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U.S. ARMY AVIATION SYSTEMS COMMAND

LOW AIRSPEED SENSOR LOCATION TESTS
AH-1G HELICOPTER

FINAL REPORT

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UNITED STATES ARMY AVIATION ENGINEERING FLIGHT ACTIVITY
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

During weapons fire control tests being conducted by Frankford Arsenal, Philadelphia, Pennsylvania, it was necessary to determine the optimum location for an Elliott low airspeed system mounted on an AH-1G helicopter to improve the accuracy of the actual aircraft airspeed signal to the fire control computer. The airspeed system was provided by Frankford Arsenal, and the necessary mounting hardware was constructed by the United States Army Aviation

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20. Abstract

airspeed indicator

Engineering Flight Activity, Edwards Air Force Base, California. Nine locations along the fuselage from the engine mount to the forward canopy area were tested. The optimum location tested was at fuselage station 128, water line 104, and buttline -35. The Frankford system was then calibrated at the optimum location, and the electronic linearization circuits were added to the computer. This location for the linearized system provided accurate airspeed information out of ground effect from 15 knots calibrated airspeed (KCAS) rearward to 125 KCAS forward, and lateral airspeed from 28 KCAS left to 25 KCAS in right sideward flight.

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INTRODUCTION

BACKGROUND

1. The Frankford Arsenal, Philadelphia, Pennsylvania, was required to install an air data system on an AH-1G helicopter as part of a weapons fire control system (enhanced Cobra fire control system). They installed the Elliott Industrial Associates Corporation low airspeed sensing and indicating equipment (LASSIE) during the firing tests, but the information obtained was not of sufficient accuracy. Previous tests of the airspeed system by the United States Army Aviation Engineering Flight Activity (USAAEFA) had shown the position error to be strongly influenced by the sensor location (USAAEFA Project Nos. 71-30 and 75-17, refs 1 and 2, app A). The sensor location used by Frankford Arsenal was unsatisfactory, and another location for the sensor was required to improve system performance. The United States Army Aviation Systems Command (AVSCOM) directed USAAEFA to conduct tests with the LASSIE installed on the AH-1G helicopter to determine a satisfactory location (ref 3).

TEST OBJECTIVES

2. The objectives of the low airspeed sensor location tests were to determine a satisfactory location for the sensor on the AH-1G helicopter and to calibrate the system at that location.

DESCRIPTION

3. The test helicopter, serial number 67-15844, was a production AH-1G manufactured by Bell Helicopter Textron of Hurst, Texas. A detailed description is contained in the operator's manual (ref 4, app A).

4. The LASSIE system consists of a finned swiveling pitot-static probe linked to pressure sensors, an air data computer, and cockpit display of longitudinal and lateral airspeed and rate of climb. The probe was mounted to utilize the rotor downwash to maintain adequate dynamic pressure on a pitot-static probe. The probe was mounted on a swivel and thus aligned itself with the relative wind (vector sum of aircraft velocity and rotor downwash). The angle of the probe was used with the differential pressure to obtain aircraft longitudinal and lateral airspeed or total velocity. The angles can also be used to calculate angles of attack and sideslip. The static pressure was differentiated with respect to time to obtain rate of climb. A further description of the LASSIE system and theory of operation is provided in appendix C. The required mounts for the different locations are shown by drawings and photographs presented in appendix C.

TEST SCOPE

5. The tests were conducted at Edwards Air Force Base, California in accordance with the approved test plan (ref 5, app A). The evaluation was partially flown in conjunction with the AH-1G flow field test (USAAEFA Project No. 74-02, ref 6), and required 20 hours of productive testing. The location optimization testing was simplified by using a LASSIE II probe available at USAAEFA, since its design provided greater simplicity and flexibility in the mounting support structure than the LASSIE III system. The LASSIE III probe was specifically designed to mount in the pylon position, which limited the flexibility of supporting structure. The aerodynamic characteristics of the swiveling probe were expected to be very similar. The LASSIE III test system was then installed and calibrated at the most satisfactory location tested.

6. Flights were conducted within limitations specified by the AVSCOM safety-of-flight release (ref 5, app A) and the operator's manual. The tests were conducted at an average gross weight of 8000 pounds, the longitudinal center of gravity (cg) was mid, and rotor speed varied from 314 to 328 rpm. The stability and control augmentation system (SCAS) was operational for all tests.

7. In-ground-effect (IGE) and out-of-ground-effect (OGE) low-speed tests were conducted at a field elevation of 2302 feet, and the high-speed tests were flown at approximately 6000 feet. Airspeed ranges investigated were from 30 knots rearward to 125 knots forward, and 35 knots to the left and right.

8. The sensor was mounted in the nine areas shown in figure A. Details of each location are presented in the discussion of test results. Each sensor location was tested to determine the relative performance of the system.

FLIGHT TEST METHODOLOGY

9. The low airspeed (zero to 40 knots) tests were conducted with a calibrated pace vehicle for ground speed reference. Wind speed and direction were recorded from a ground station anemometer. Reference airspeed was obtained by correcting ground speed data for wind speed and direction. Airspeed data were also obtained from a calibrated Pacer Systems Inc., low-range airspeed system (LORAS 1000) mounted on the rotor mast. Tests were conducted in winds less than 5 knots, and aircraft height above the ground was measured by a radar altimeter. The tests were conducted in stabilized level flight in the longitudinal and lateral directions. Dynamic maneuvers were not tested.

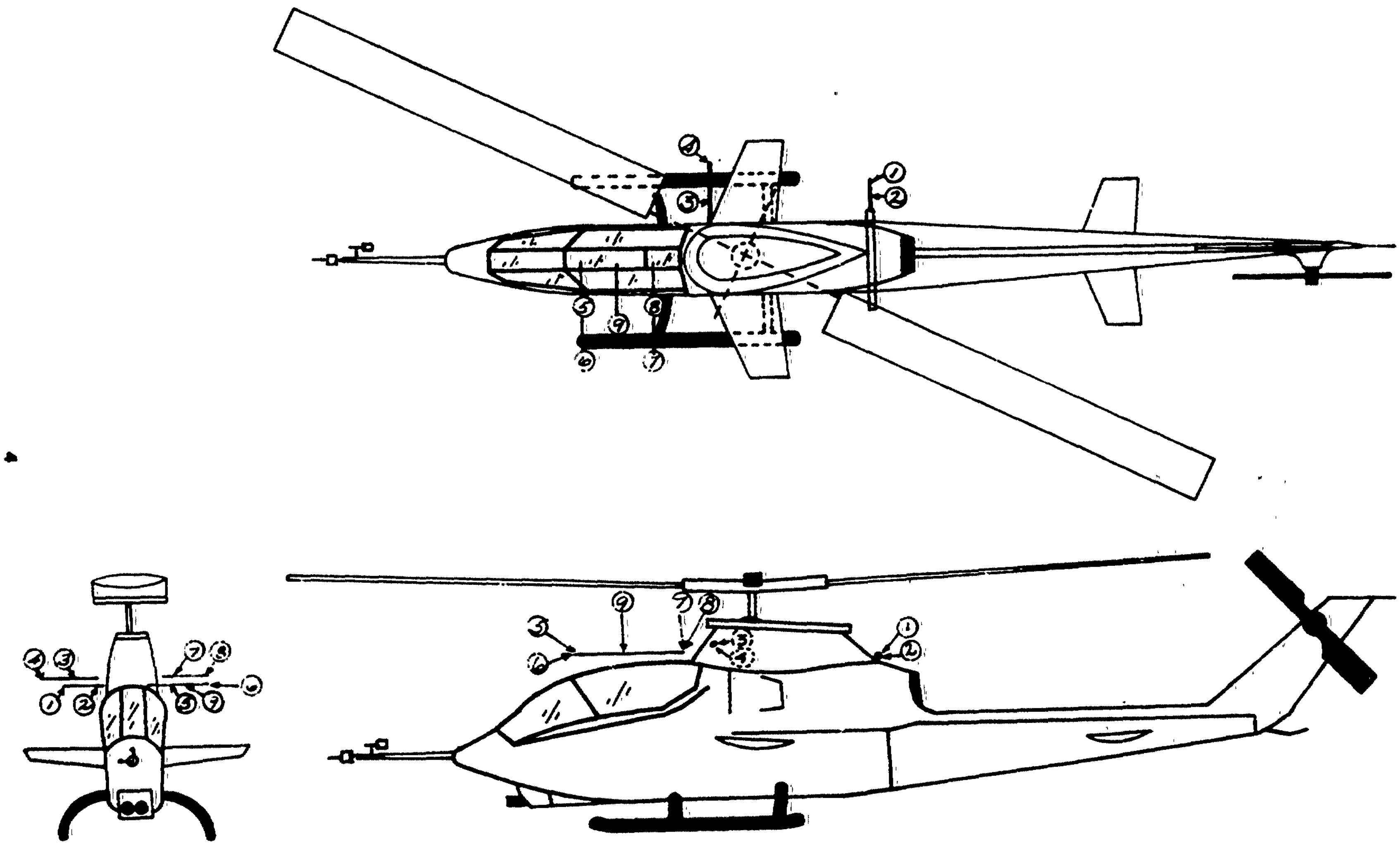


Figure A. Test Positions for the Elliott Airspeed Probe.

10. The high-speed reference was the calibrated swivel-head pitot-static probe mounted on a nose boom and the LORAS 1000 system mounted on the rotor mast. Sideslip and angle of attack were measured by vanes located on the boom.

11. The airspeed sensor and aircraft parameters were recorded by an airborne magnetic tape system. Test data were obtained by averaging the recorded data over 10 to 20 seconds of steady flight conditions. A list of the test instrumentation used is presented in appendix B.

RESULTS AND DISCUSSION

GENERAL

12. The airspeed system output reflected the variation in airflow at the different locations, since each location produced a different position error. The most satisfactory location was determined with the LASSIE II system and then the LASSIE III system was calibrated at that location. With the electronic linearization circuits added, the system produced repeatable linear output when OGE for airspeeds from 15 knots calibrated airspeed (KCAS) rearward to 125 KCAS forward and from 28 KCAS in left sideward flight to 25 KCAS in right sideward flight. The electronic linearization of the LASSIE III system minimized the position error and removed the discontinuity that occurred when the probe transitioned from rotor downwash to free stream airflow.

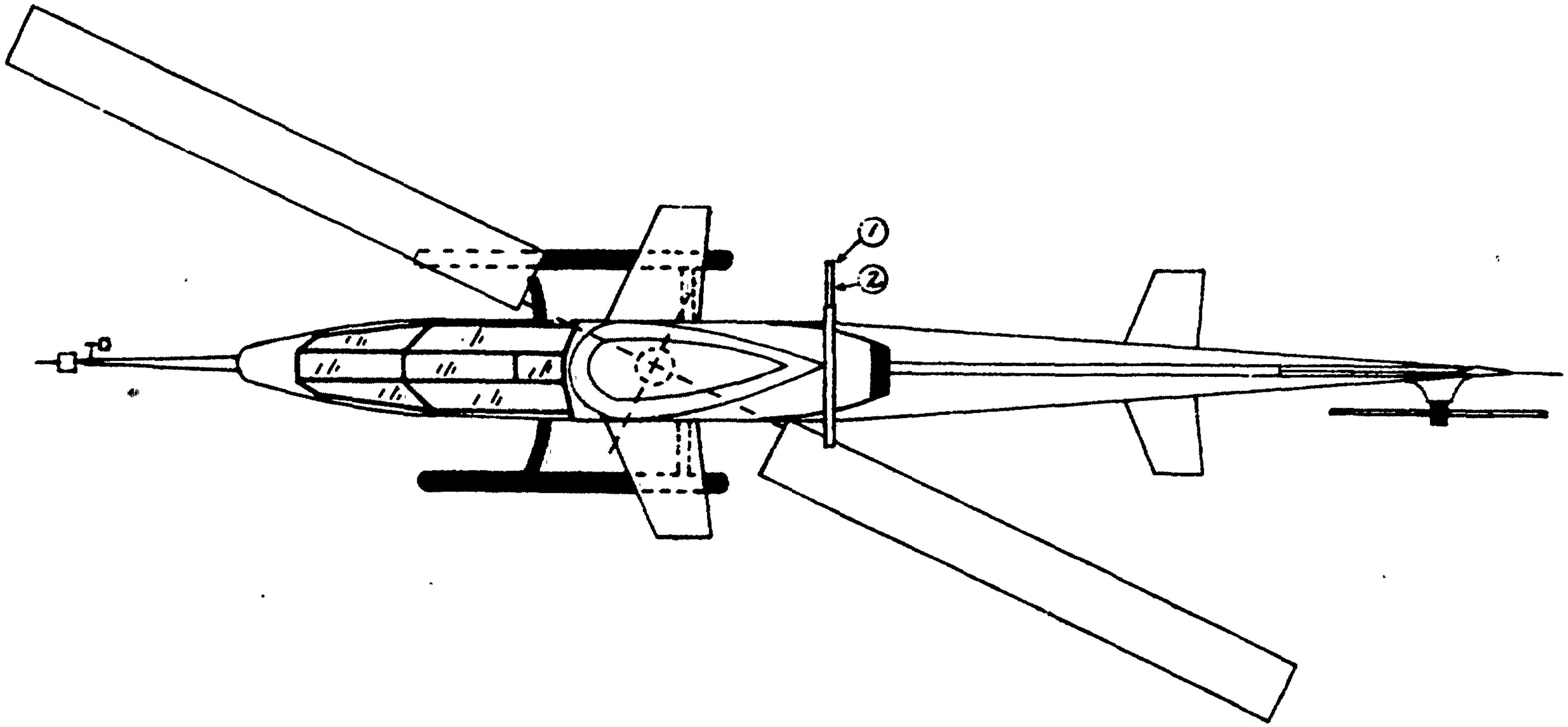
Sensor Location Tests

Engine Mount Location:

13. The sensor was mounted at the positions shown in figure B. The sensor performance for these two positions is presented in figures 1 through 4, appendix D.

14. In position 1, the sensor was not responsive in the area from hover to 10 KCAS forward. At airspeeds above 10 KCAS, the system functioned and showed distinctly different characteristics for the ranges of 10 to 30 KCAS than for 30 to 110 KCAS. The sensor apparently did not transition smoothly from rotor wash to free stream flow. Lateral airspeed was repeatable, but nonlinear, from 12 KCAS left to 26 KCAS right sideward flight. At left sideward airspeeds above 12 KCAS, the readings were erratic and low.

15. Moving the sensor aft and inboard to position 2 considerably improved system performance in forward and rearward flight (fig. 3, app D). From 19 KCAS rearward to 115 KCAS forward, the system output was linear, with the exception of the forward airspeed area from 15 to 40 KCAS. Above 105 KCAS another major transition region occurred which caused nonlinear performance. In all cases, the data were repeatable. For sideward flight of 12 KCAS left to 25 KCAS right (fig. 4) system performance was much the same as for position 1. At left sideward airspeeds above 12 KCAS, the flow conditions were improved; however, the system output was still unusable.



Sensor position	Fuselage station	Water line	Buttline
1	275 in.	105 in.	28 in.
2	282 in.	110 in.	20 in.

Figure B. Engine Mounting Locations.

Pylon Mount Location:

16. Figure C illustrates the two pylon locations tested. Test results for the pylon locations are presented in figures 5 through 8, appendix D. The data between 5 and 60 KCAS are missing on figure 5 due to an instrumentation malfunction, but the observed performance in this region was similar to figure 6.

17. The overall forward airspeed system performance was essentially the same in both locations. The airspeed indication was linear from 25 KCAS rearward to 25 KCAS forward. However, there was a discontinuity as the probe transitioned from rotor downwash to free stream air between 25 and 30 KCAS. There was less variation about the average in the outboard location.

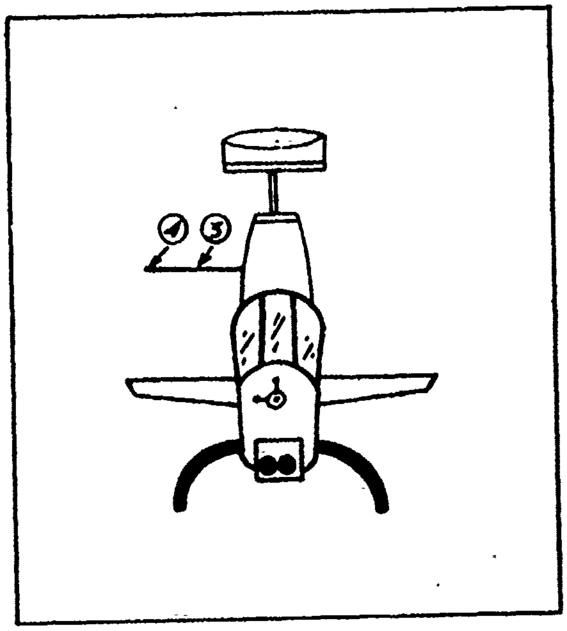
18. In lateral flight system performance was similar in both locations. The average indicated airspeed was repeatable and nonlinear from 27 KCAS left to 26 KCAS right. However, the variation about the mean was less at the outboard location, as was the discontinuity between zero and 5 KCAS observed on the inboard location (fig. 6, app D).

Canopy Mount Location:

19. An adjustable bracket mounted on top of the canopy was used to facilitate evaluation of five different locations. These locations are identified in figure D.

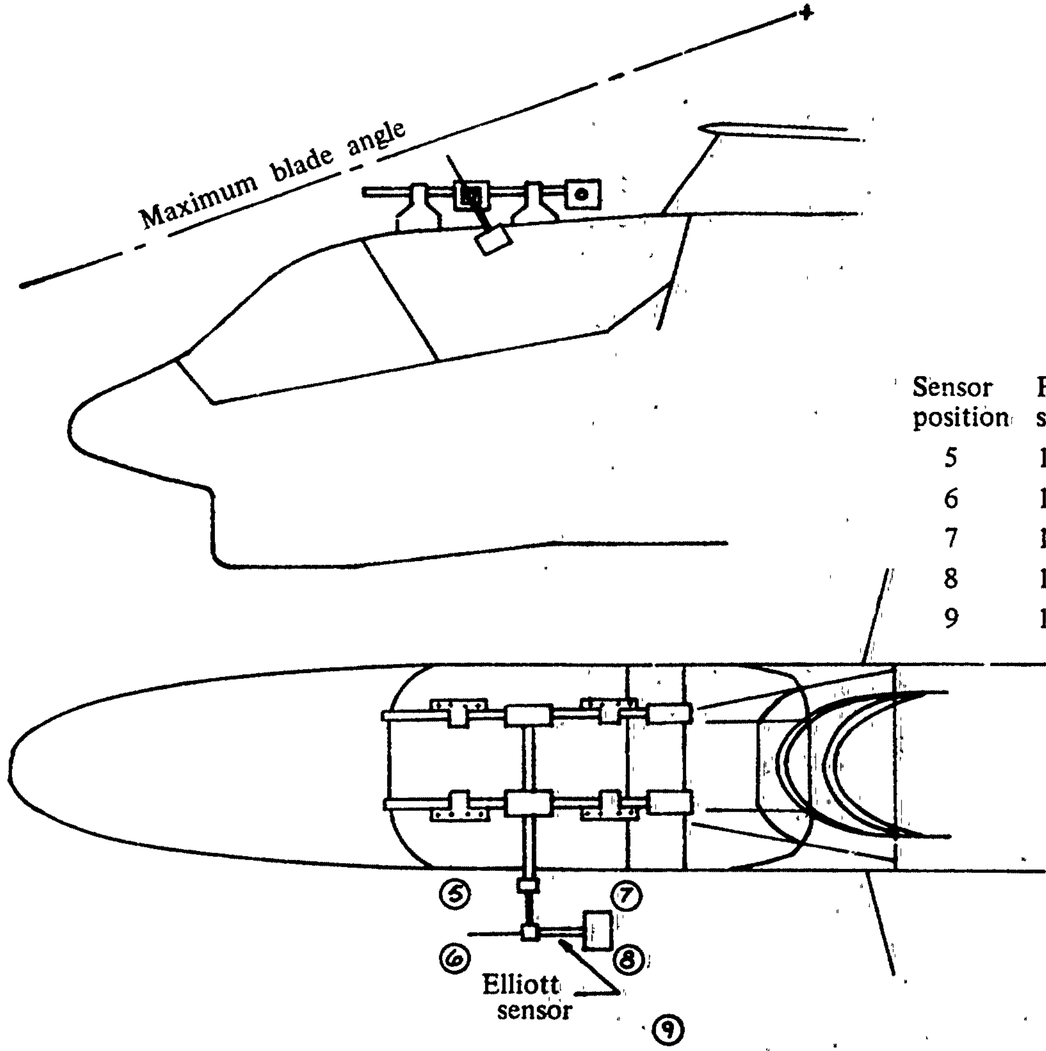
20. The system's longitudinal airspeed performance is shown in figures 9, 11, 13, 15, and 17, appendix D. The characteristics of the longitudinal airspeed indications were the same for all five locations. Between 20 and 30 KCAS, there was a discontinuity as the probe transitioned from the rotor wake to free stream. The system was generally operable to 30 KCAS rearward, and the indication was linear. The position error varied for each location, but in all cases, the indicated airspeed was less than the actual airspeed. After the probe transitioned to free stream, the uncorrected system output was linear, with airspeed error becoming higher as calibrated airspeed increased.

21. The system's lateral airspeed performance is shown in figures 10, 12, 14, 16, and 18, appendix D. In all five locations, system performance characteristics during lateral flight were essentially the same. During left sideward flight, the system provided airspeed information to the test limit of 35 knots. For right sideward flight, the system was usable to 15 to 20 KCAS, depending on location. Beyond 20 KCAS, there was an apparent airflow disturbance, and the system was not usable. As the sensor was progressively moved from position 5 to position 9, the airspeed indications became less erratic and more linear. The influence of ground effect also diminished. The final data obtained with the LASSIE II sensor in location 9 are shown in figures 17 and 18.



Sensor position	Fuselage station	Water line	Buttline
3	177 in.	106 in.	48 in.
4	177 in.	106 in.	60 in.

Figure C. Pylon Mount Locations.



Sensor position	Fuselage station	Water line	Buttline
5	119.7 in.	104 in.	28.0 in.
6	119.7 in.	104 in.	43.3 in.
7	136.5 in.	105 in.	43.3 in.
8	136.5 in.	105 in.	28.0 in.
9	128.5 in.	104 in.	35.0 in.

Figure D. Canopy Mounting Locations.

Airspeed System Calibration

22. The LASSIE III sensor was mounted at fuselage station 128, water line 104, and buttline -35 (location 9), which was judged the best on the basis of the location survey. Tests were conducted to define the characteristics of the probe and confirm that the two sensor models had similar performance. Results of these tests are shown in figures 19 and 20, appendix D.

23. These data were supplied to the contractor, who adjusted the electronics to correct the position error and linearize the indicated airspeed signal (electronic linearization). Flight tests were then conducted to calibrate the final configuration in the optimum location. The effects of the linearization are best seen by comparing figures 19 and 20 with figures 21 and 22, appendix D. The linearization minimized the position error and removed the discontinuity that occurs when the probe transitions from rotor downwash to free stream airflow.

24. Figure 21, appendix D, shows that the system has a negligible position error from hover to 125 KCAS (the highest airspeed tested). In rearward flight, the system was not usable at airspeeds greater than 10 KCAS, which indicated degraded performance from the LASSIE II system. The position error was changed in IGE flight between zero and 30 KCAS, and the LASSIE III system was not usable at rearward airspeeds greater than 5 KCAS.

25. In lateral flight system performance was the same both IGE and OGE. Figure 22, appendix D, shows no error at hover. The system output was linear from 28 KCAS left to 25 KCAS right. However, the slope was less than one, which caused the system to read increasingly low as airspeed was increased from hover. Output was questionable for left airspeeds greater than 28 KCAS and not usable for airspeeds beyond 25 KCAS to the right.

CONCLUSIONS

26. Each sensor location produced a different position error.

27. The most satisfactory sensor location found during these tests was on the left side of the canopy, at fuselage station 128, water line 104, and buttline -35 (position 9) (para 22).

28. The electronic linearization of the LASSIE III system minimized the position error and removed the discontinuity that occurred when the probe transitioned from rotor downwash to free stream airflow (para 23).

29. The LASSIE II and III systems have the same operating characteristics and similar accuracy, except at rearward airspeeds greater than 10 KCAS (para 24).

30. For the most satisfactory location, the LASSIE III system with electronic linearization provided accurate airspeed information from 10 KCAS rearward to 125 KCAS forward, and lateral airspeed from 28 KCAS left sideward to 25 KCAS right sideward flight (paras 24 and 25).

RECOMMENDATIONS

31. For best system performance the LASSIE III system should be located at fuselage station 128, water line 104, buttline -35 (position 9) on the AH-1G helicopter.

APPENDIX A. REFERENCES

1. Final Report I, US Army Aviation Systems Test Activity, Project No. 71-30, *Flight Evaluation, Elliott Low Airspeed System,* September 1972.

2. Test Plan, USAAEFA, Project No. 75-17, *Flight Evaluation of Two Low Airspeed Sensor Systems*, June 1975.

3. Letter, AVSCOM, AMSAV-EQI, 3 July 1975, subject: Low Airspeed Sensor Location Tests, AH-1G, USAAEFA Project No. 75-19.

4. Technical Manual, TM 55-1520-221-10, *Operator's Manual, Army Model AH-1G Helicopter,* 19 June 1971, with Changes 1 through 11.

5. Test Plan, USAAEFA, Project No. 75-19, *Low Airspeed Location Tests, AH-1G Helicopter,* September 1975.

6. Test Plan, USAAEFA, Project No. 74-02, *Rotor Flow Survey Program, AH-1G Cobra Helicopter,* March 1975, to be published.

APPENDIX B. INSTRUMENTATION

1. The test instrumentation included the following:

   Pilot Panel

   Airspeed (boom)
   Airspeed (LORAS forward)
   Airspeed (LORAS lateral)
   Airspeed (Elliott forward)
   Airspeed (Elliott lateral)
   Altitude (boom)
   Rate of climb (boom)
   Rotor speed
   Angle of sideslip (boom)
   Radar altimeter

   Engineer Panel

   Airspeed (boom)
   Altitude (boom)
   Outside air temperature
   Fuel counter
   Data system controls

2. Data parameters recorded on the digital (PCM) system were as follows:

   Time of day
   Engineer event
   Run number counter
   Rotor blip
   Fuel counter
   Rotor speed (analog)
   Rotor speed (digital)
   Altimeter (radar)
   Pressure altitude (boom)
   Angle of attack (boom)
   Angle of sideslip (boom)
   Airspeed low range (boom)
   Airspeed high range (boom)
   Airspeed (LORAS longitudinal)
   Airspeed (LORAS lateral)
   Airspeed (Elliott total)
   Airspeed (Elliott longitudinal)
   Airspeed (Elliott Lateral)

Angle of attack (Elliott)
Angle of sideslip (Elliott)
Pitch attitude
Roll attitude
Lateral swashplate angle
Longitudinal swashplate angle
Ambient air temperature

APPENDIX C. SYSTEM DESCRIPTION AND THEORY OF OPERATION

1. The system consists of an airspeed probe, a rate transducer, a vertical speed indicator, longitudinal and lateral airspeed indicators, and a computer.

2. The swiveling dual-axis pitot-static probe (type 05-006-01) is a standard pitot-static sensing head with four peripheral static parts. The circular vane, with space wedges at 120 degrees, is slightly unbalanced to permit pendulous action. Two synchro resolvers are mounted within the assembly to measure the probe angular position. The total and static air pressures are piped to the airspeed computer along with the probe angle signals from the synchro resolvers.

3. The rate transducer (type 60-SK-3437) is an electromechanical design and has a gearbox to drive synchros and potentiometer outputs. Also contained in the unit is an electrical force balance transducer which is used as a pressure altitude sensor. This unit produces the pressure altitude and rate of climb, which are displayed on the cockpit indicators. These signals may also be recorded by an instrumentation system.

4. The vertical speed indicator (VSI) (type 71-012-01) contains a servo amplifier, motor, and position feedback potentiometer. Input signals supplied from the rate transducer are fed into the instrument servo amplifier which in turn drives the motor. Position feedback from the potentiometer within the instrument is fed back to the rate transducer VSI control amplifier.

5. The longitudinal airspeed indicator (type 71-011-01) consists of a stepper motor and a feedback potentiometer. This provides an indicator rate signal and position signal which is fed back to the airspeed computer. The signals are summed with the computer longitudinal airspeed and are checked by the servo monitor. Detected failures are indicated by a warning flag on the indicator.

6. The lateral airspeed indicator (type 71-010-01) is similar to the longitudinal indicator and operates in the same manner. Pressure altitude is indicated on an AAU-19 servo altimeter.

7. If the pitot-static probe is mounted below the rotor, and is arranged to rotate such that it is always pointing into the resultant flow, then the sensed impact pressure will be proportional to the vectorial sum of the induced and transitional components of air velocity. The fundamental relationships involved are illustrated in figure 1.

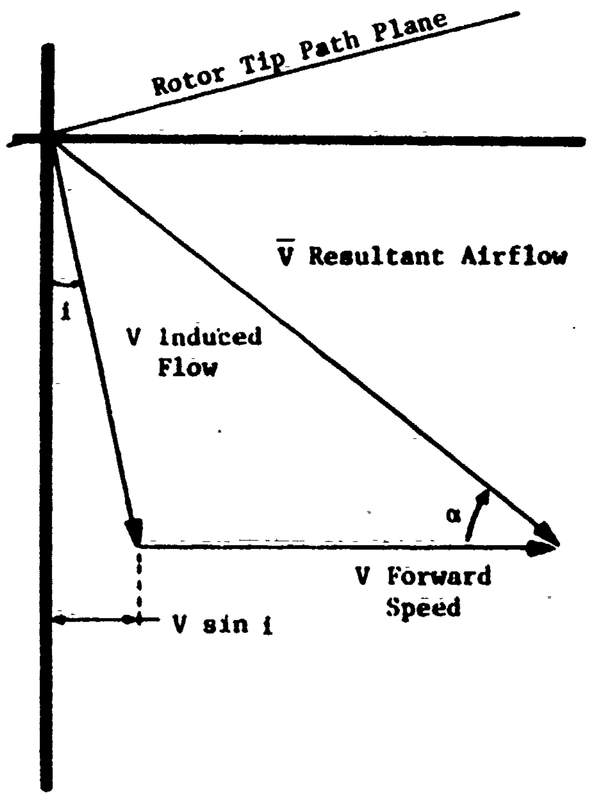


Figure 1. Resolution of Flow Under the Rotor.

Where:

$\overline{V}$ = Resultant airflow

V = Forward speed

v = Induced flow

i = Rotor incidence angle

α = Probe angle relative to fuselage

8. Since at low airspeed i is small and at high airspeed v is small, the equation can be simplified and horizontal airspeed can be obtained from:

$$V = V \cos \alpha$$

This arrangement has several fundamental advantages:

a. The sensor will never be required to measure impact pressure less than about 1.0 millibar (0.29 inch of mercury), since in every known operational helicopter the resultant flow ($\overline{V}$) exceeds 25 knots in hover.

b. Reversal of flight direction produces a reversal of sign in the output, thus indicating direction of motion of airframe relative to heading.

c. The static source will be aligned with the local airstream, thus minimizing the effects of flight attitude, motion, and aircraft configuration (*ie*, doors open/shut, external weapon loads, etc).

9. The vector geometry of the dual-axis system is illustrated in figure 2, from which it may be seen that:

Fore/aft airspeed (V_F) = $\overline{V} \cos \alpha \cos \beta$

Sideward airspeed (V_L) = $\overline{V} \sin \beta$

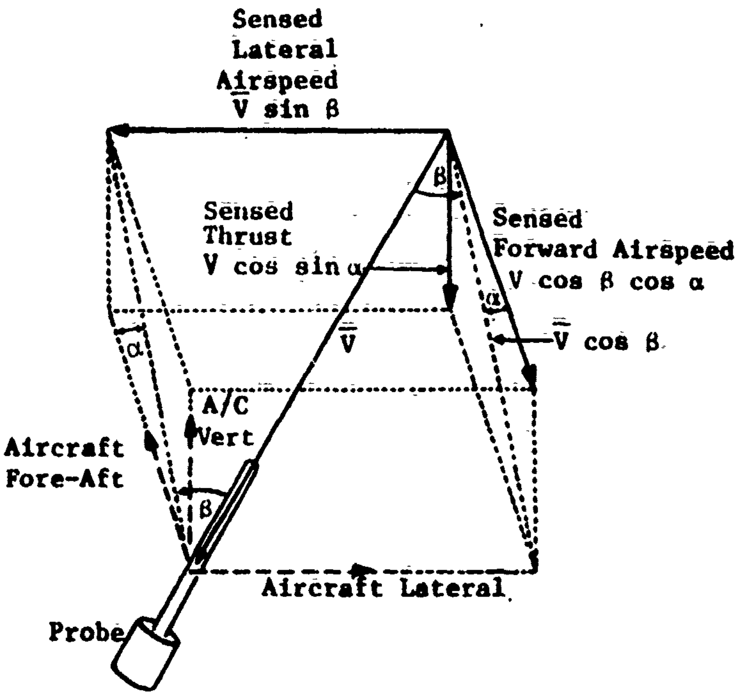
Where:

$\overline{V}$ = Resultant airflow

α = Probe angle relative to fuselage

β = Probe angle relative to aircraft datum in roll/yaw plane

It is also apparent from figure 2 that while the probe is within the downwash it is possible to compute the vertical component of velocity relative to the airframe from the available data. In addition, an indication of the magnitude and direction of the thrust vector is available.



Solid lines = Resultant airstream vector ($\bar{V}$), and components in aircraft axes.

Dashed lines = Aircraft reference axes.

(Dotted lines = Construction only)

Figure 2. Two-Axis Resolution of Flow Under Rotor.

APPENDIX D. TEST DATA

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FIGURE 1

AIRSPEED CALIBRATION IN FORWARD AND REARWARD FLIGHT

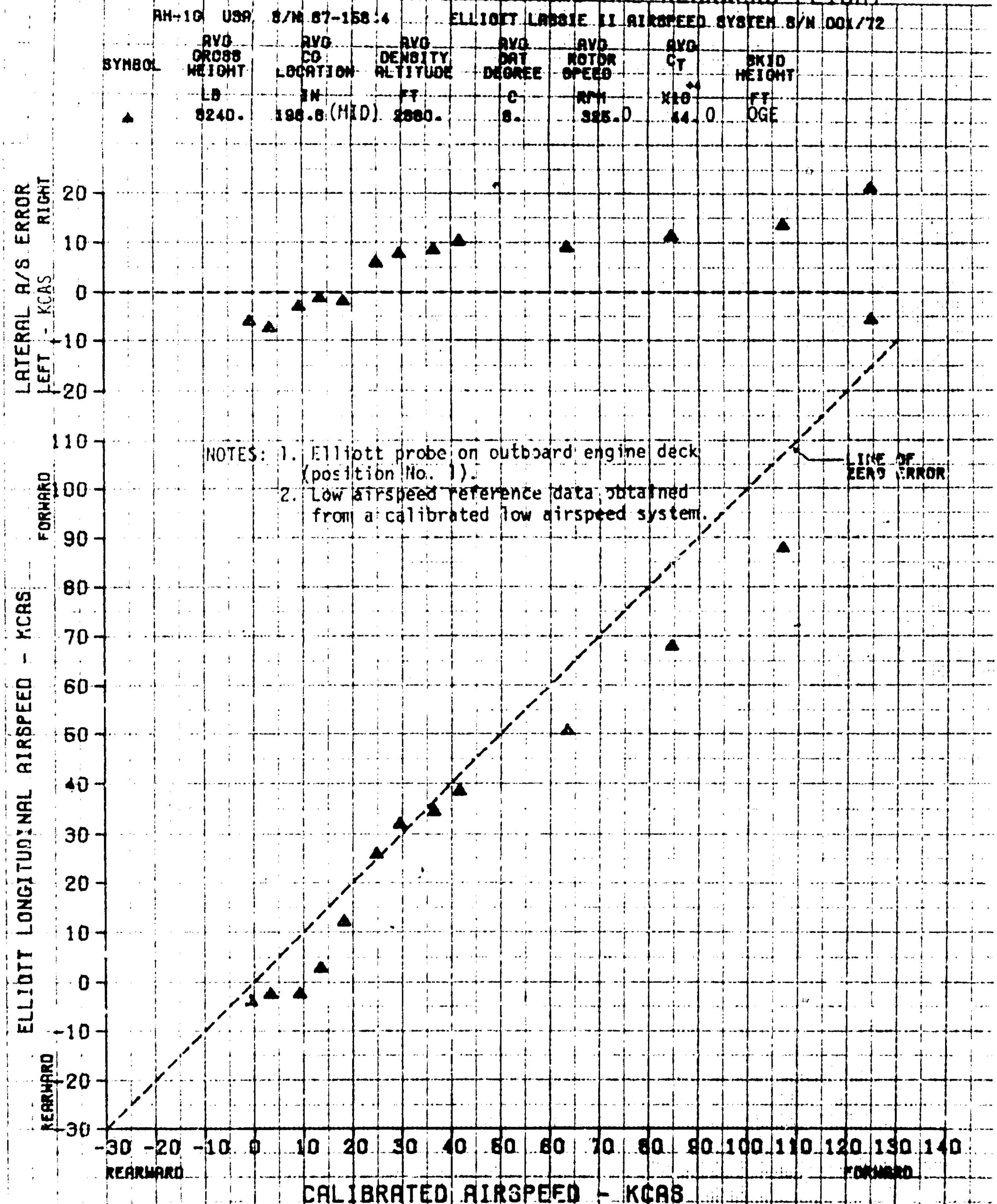


FIGURE 2

AIRSPEED CALIBRATION IN SIDEWARD FLIGHT

AH-1G USA S/N 67-15844 ELLIOTT LASSIE II AIRSPEED SYSTEM S/N 001/72

SYMBOL	AVG GROSS WEIGHT LB	AVG CG LOCATION IN	AVG DENSITY ALTITUDE FT	AVG OAT DEGREE C	AVG ROTOR SPEED RPM	AVG C_T $X10^4$	SKID HEIGHT FT
▲	7930.	198.3 (MID)	4810.	7.	328.	45.	OGE

NOTES: 1. Elliott probe on outboard engine deck (position No. 1)
2. Low airspeed reference data obtained from a calibrated low airspeed system.

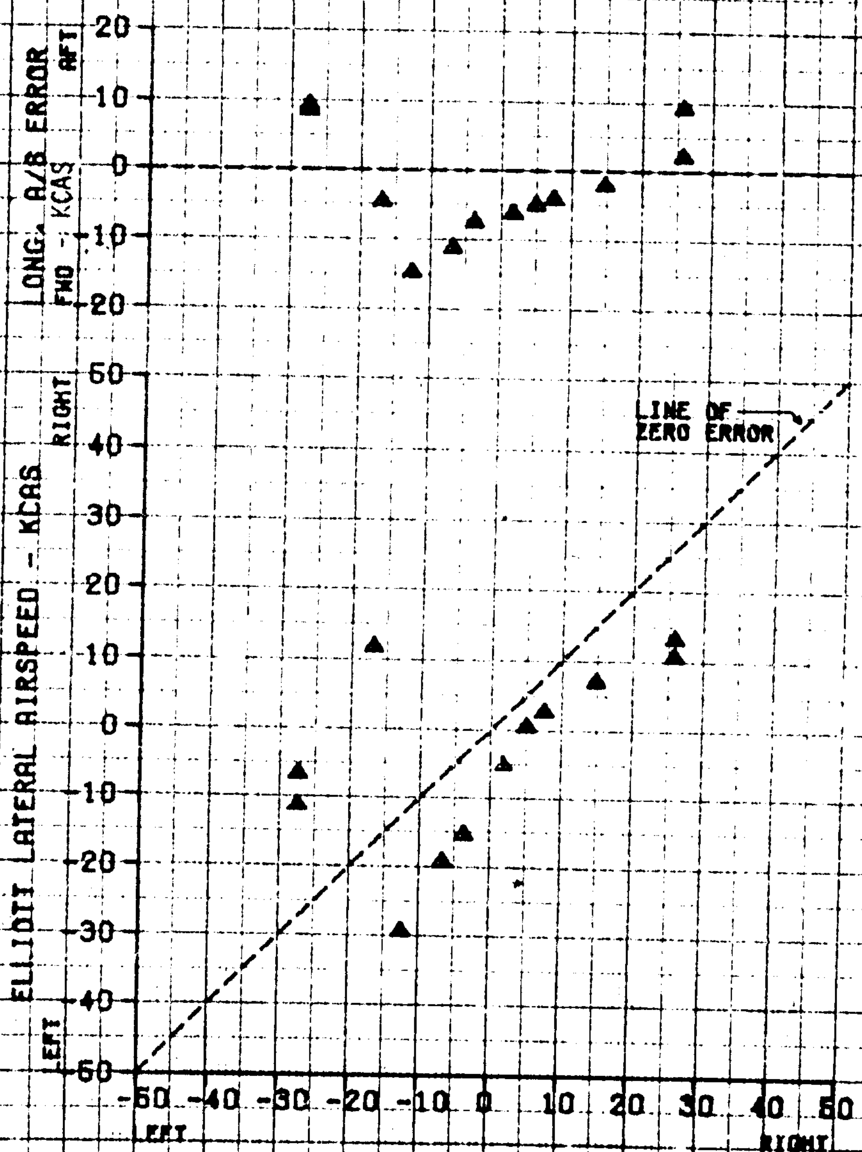


FIGURE 3

AIRSPEED CALIBRATION IN FORWARD AND REARWARD FLIGHT

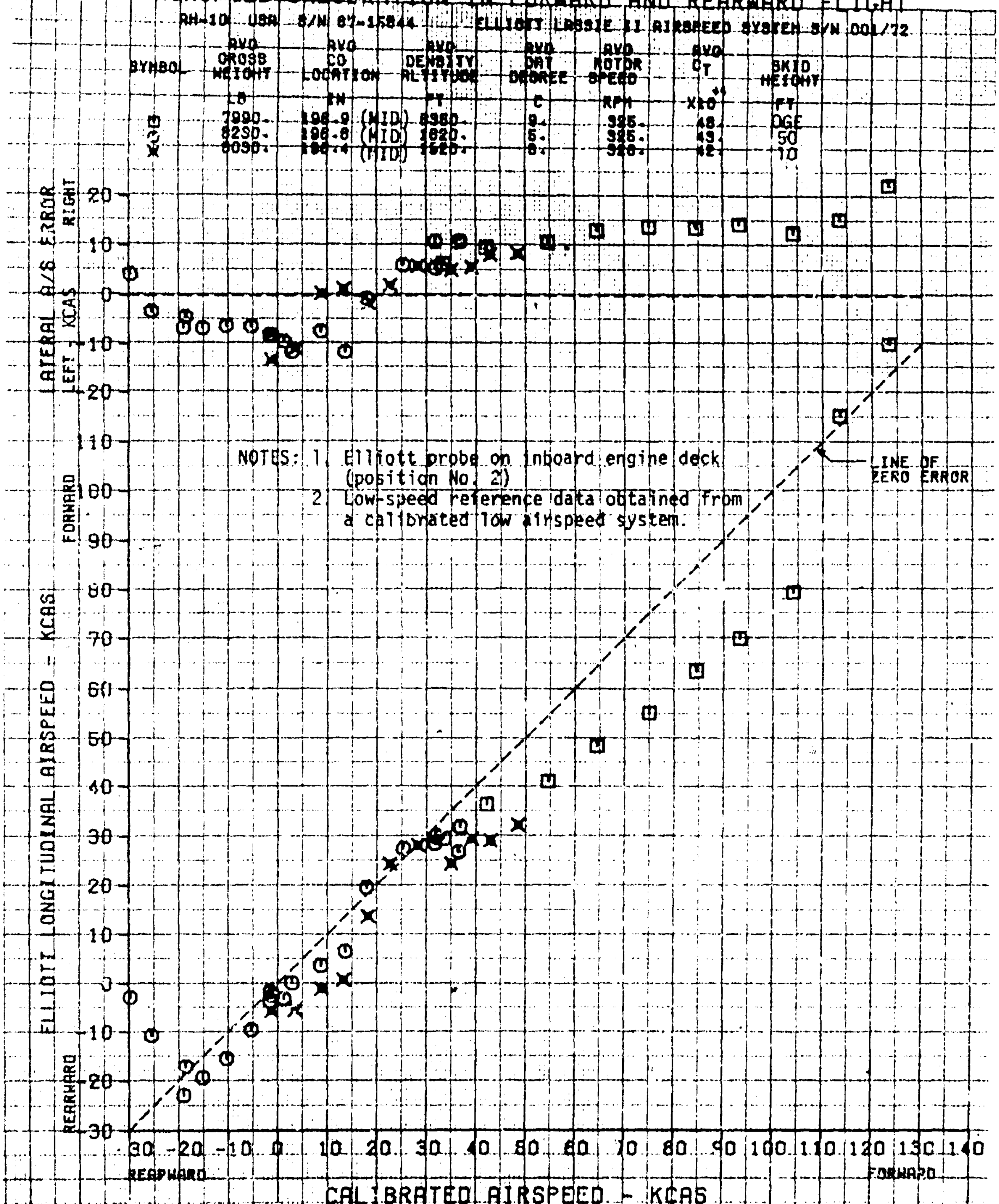


FIGURE 4

AIRSPEED CALIBRATION IN SIDEWARD FLIGHT

AH-1G USA S/N 67-15844 ELLIOTT LASSIE II AIRSPEED SYSTEM S/N 001/72

SYMBOL	AVG GROSS WEIGHT LB	AVG CG LOCATION IN	AVG DENSITY ALTITUDE FT	AVG OAT DEGREE C	AVG ROTOR SPEED RPM	AVG C_T $X10^4$	SKID HEIGHT FT
⊙	8200.	198.5 (MID)	183?.	5.	324.	43.	50

NOTES: 1. Elliott probe on inboard engine deck (position No. 2)
2. Low-speed reference data obtained from a calibrated low airspeed system.

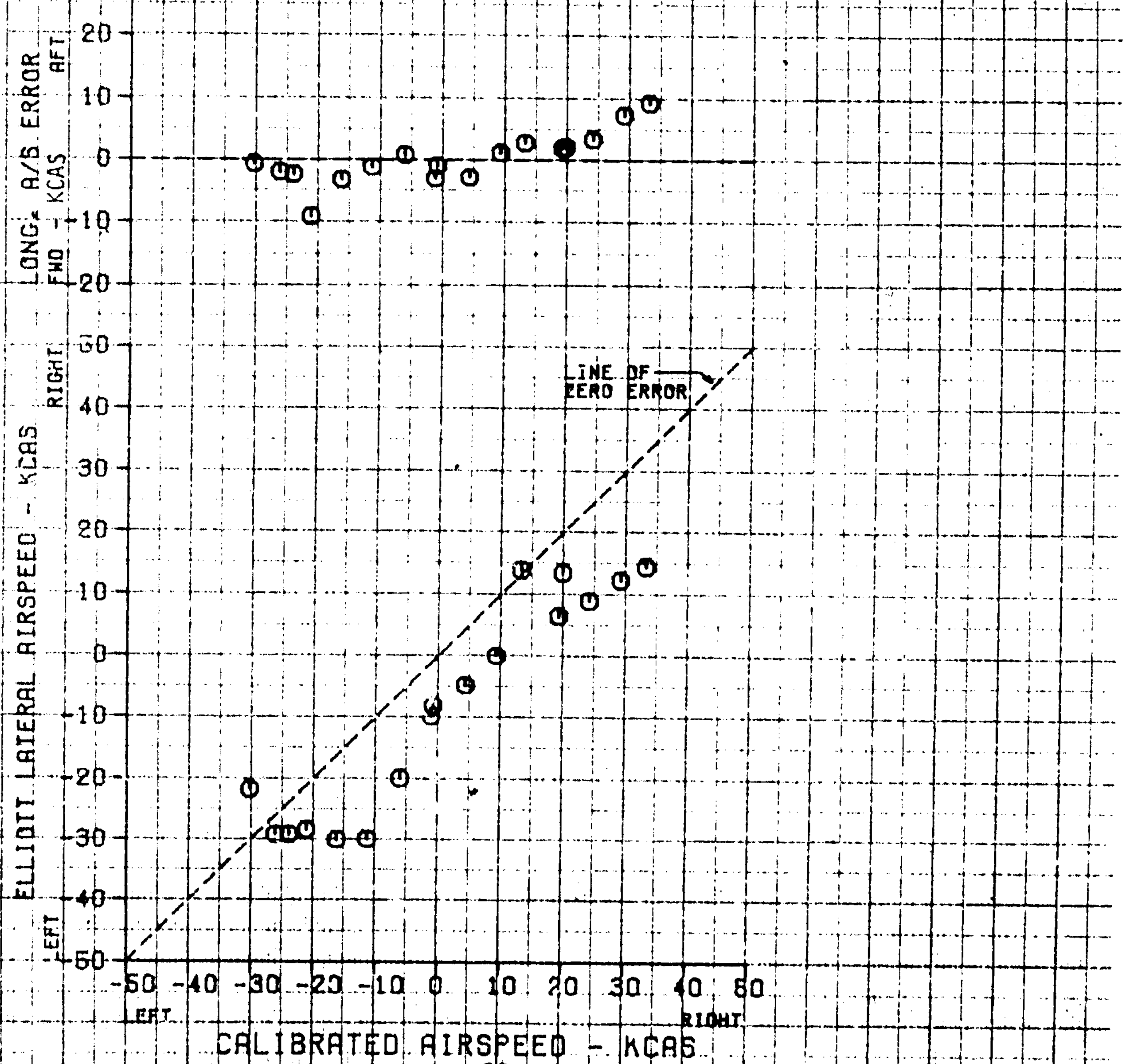


FIGURE 5

AIRSPEED CALIBRATION IN FORWARD AND REARWARD FLIGHT

AH-1G USA S/N 67-15844 ELLIOTT LASSIE II AIRSPEED SYSTEM S/N 001/72

SYMBOL	AVG GROSS WEIGHT LB	AVG CG LOCATION IN	AVG DENSITY ALTITUDE FT	AVG OAT DEGREE C	AVG ROTOR SPEED RPM	AVG C_T $\times 10^{-4}$	SKID HEIGHT FT
⊡	7890.	196.2 (MID)	5840.	5.	325.	48.	OGE

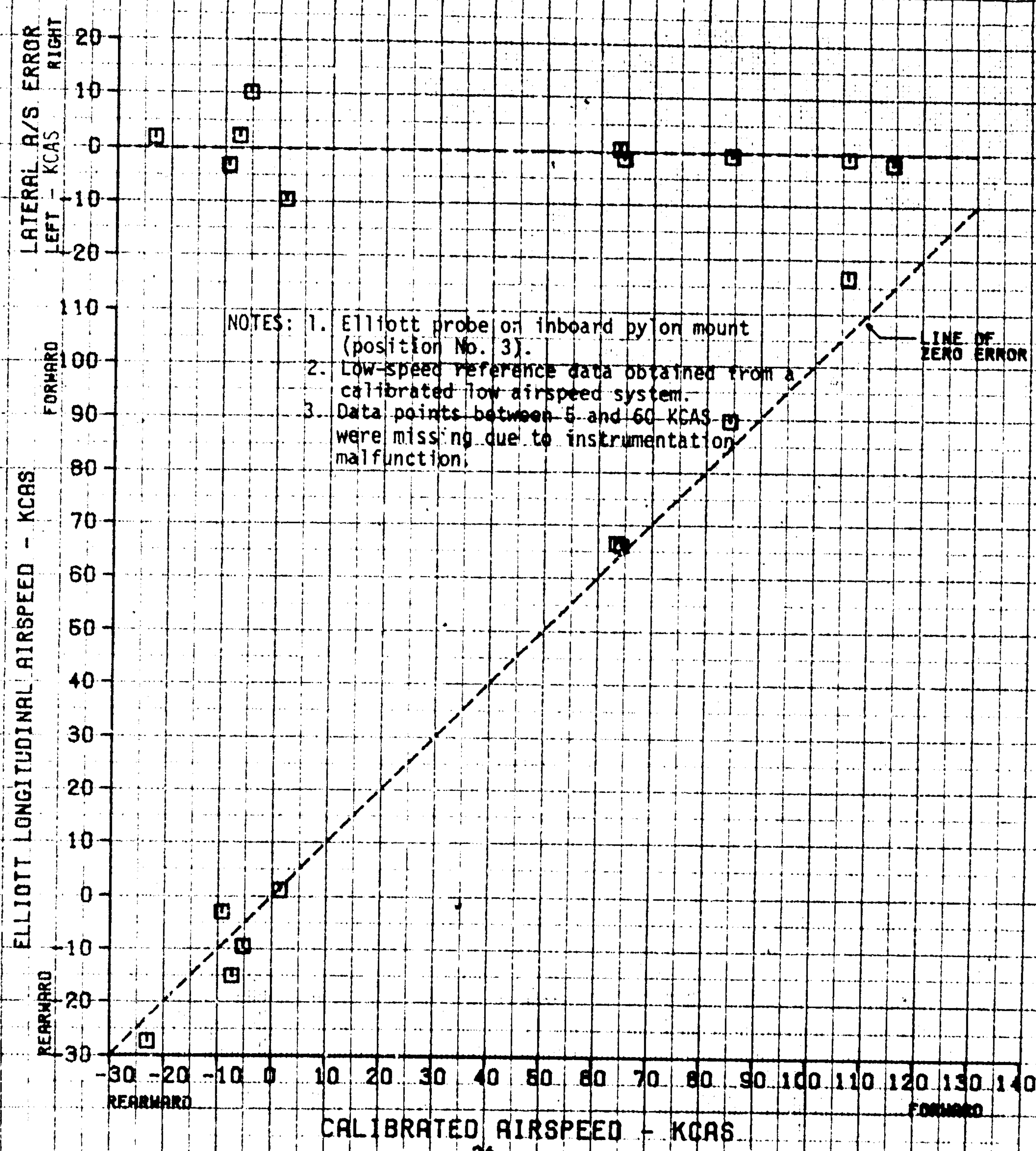


FIGURE 6
AIRSPEED CALIBRATION IN SIDEWARD FLIGHT

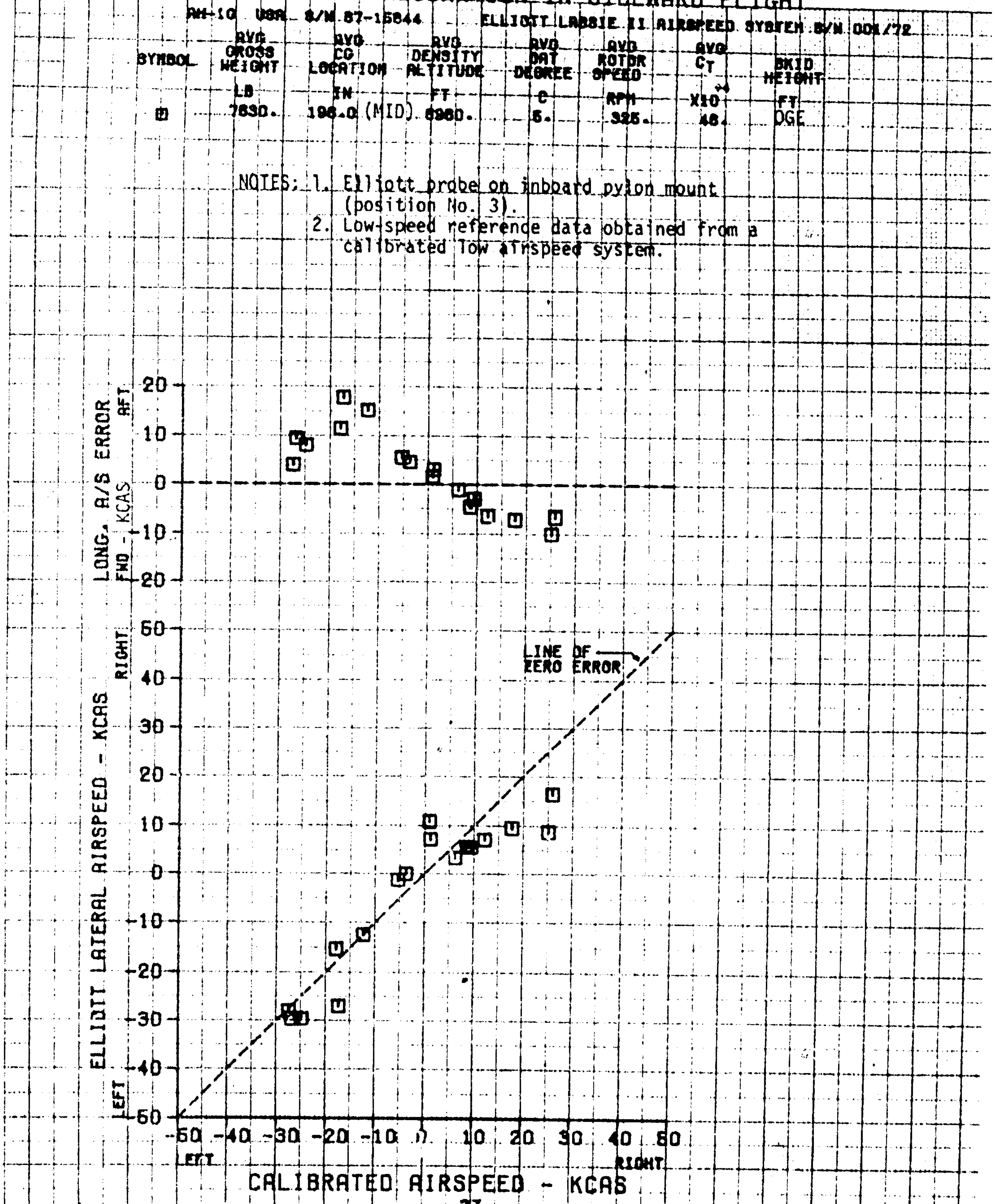


FIGURE 7

AIRSPEED CALIBRATION IN FORWARD AND REARWARD FLIGHT

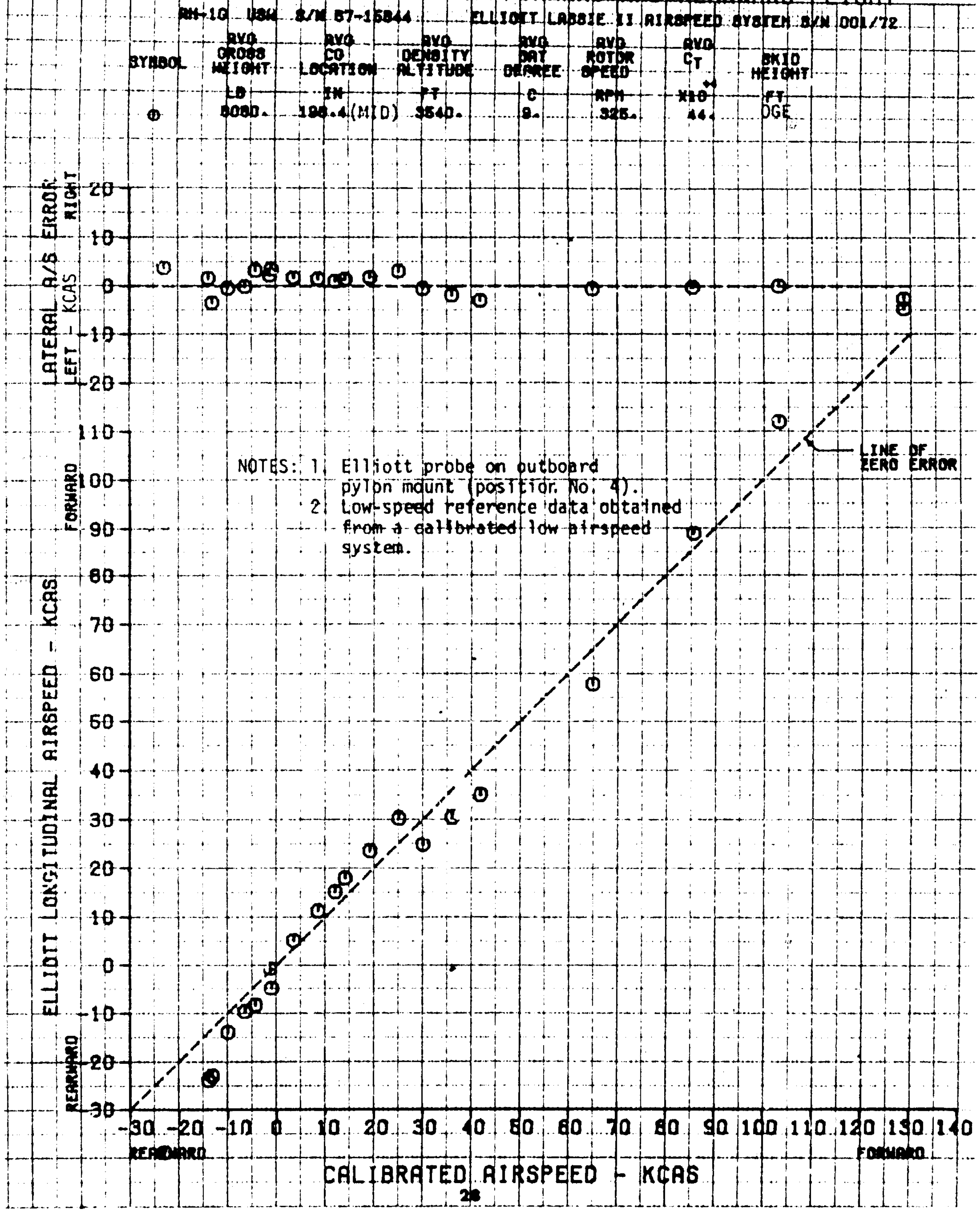


FIGURE 8

AIRSPEED CALIBRATION IN SIDEWARD FLIGHT

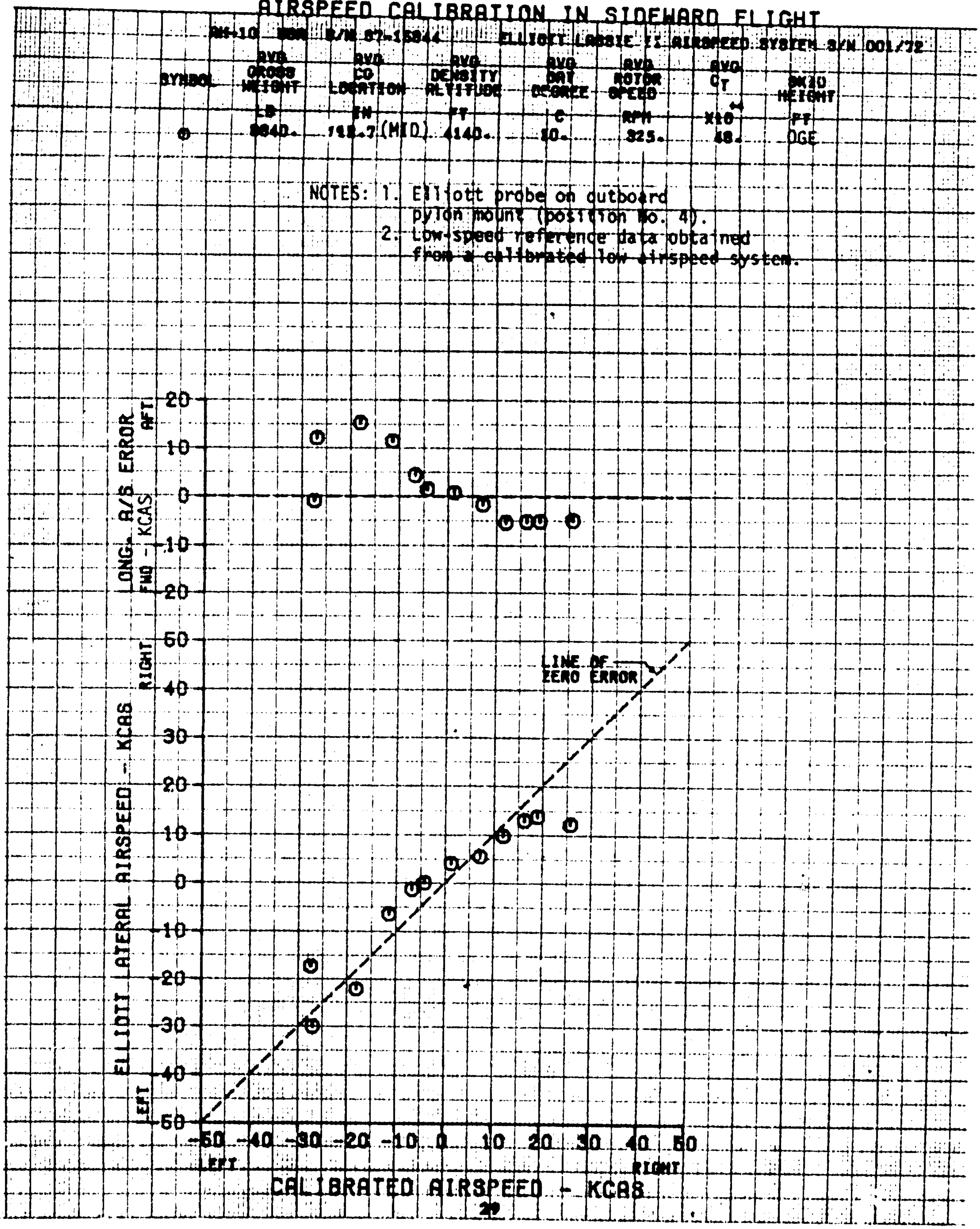


FIGURE 9

AIRSPEED CALIBRATION IN FORWARD AND REARWARD FLIGHT

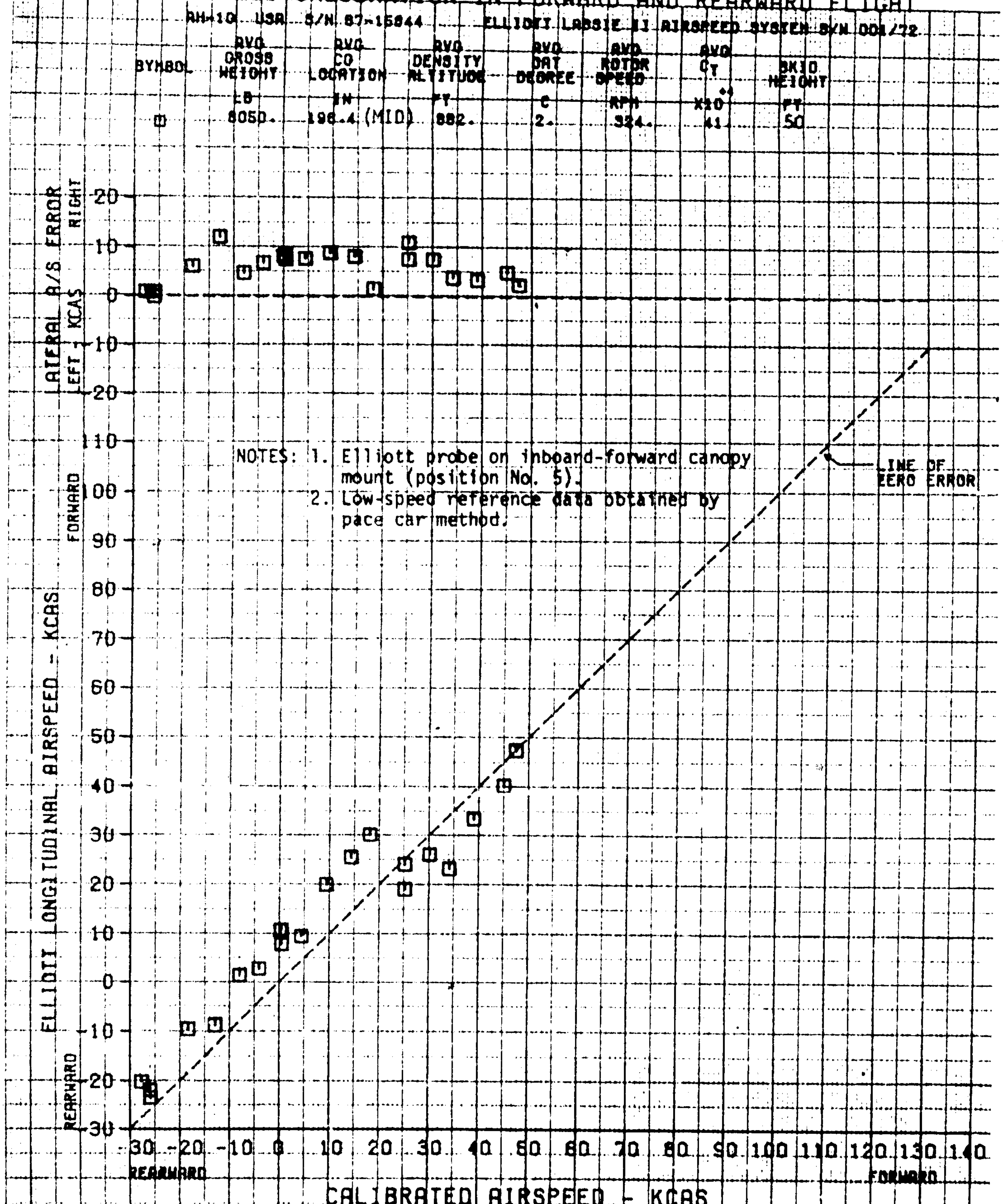


FIGURE 10

AIRSPEED CALIBRATION IN SIDEWARD FLIGHT

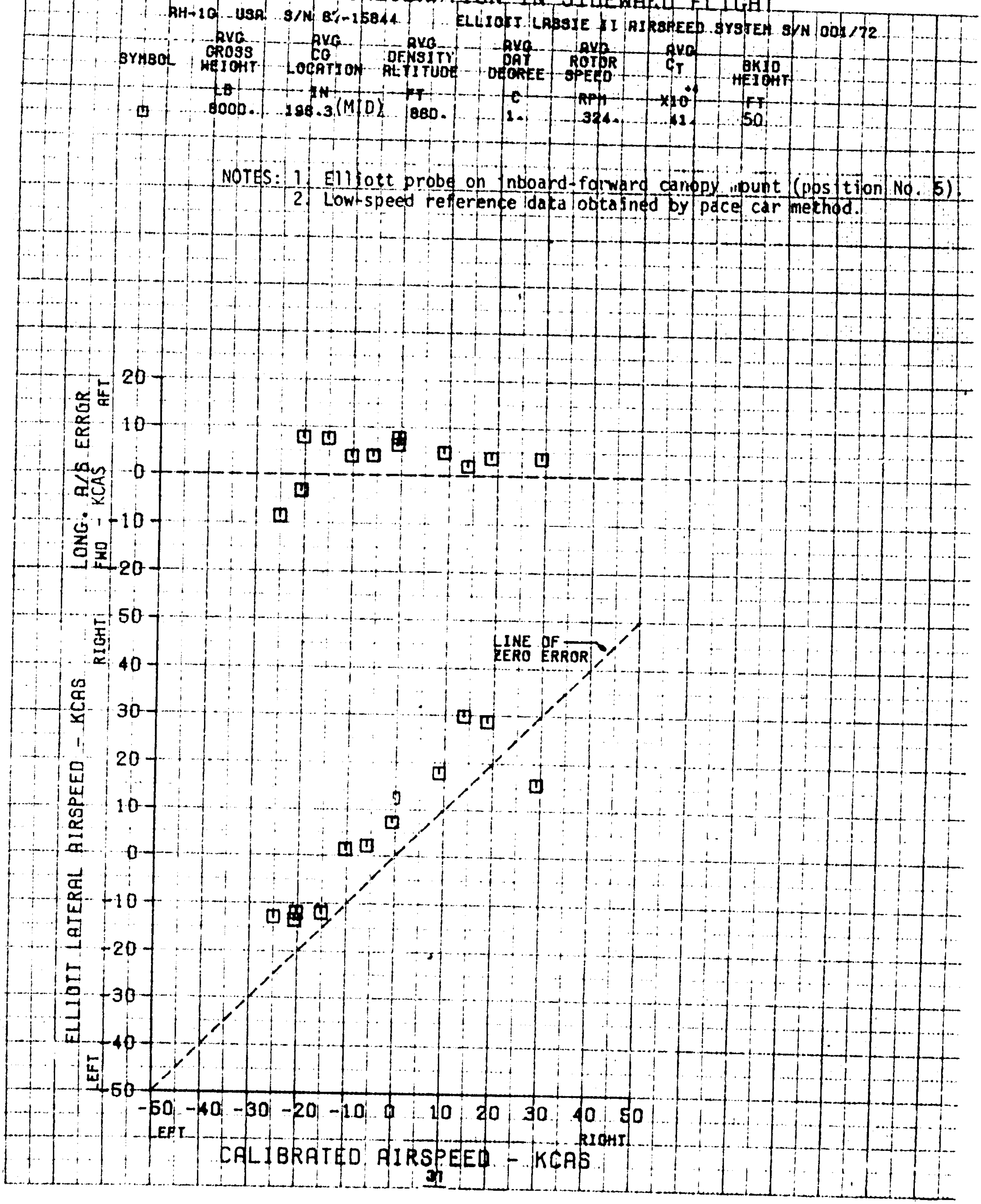


FIGURE 11

AIRSPEED CALIBRATION IN FORWARD AND REARWARD FLIGHT

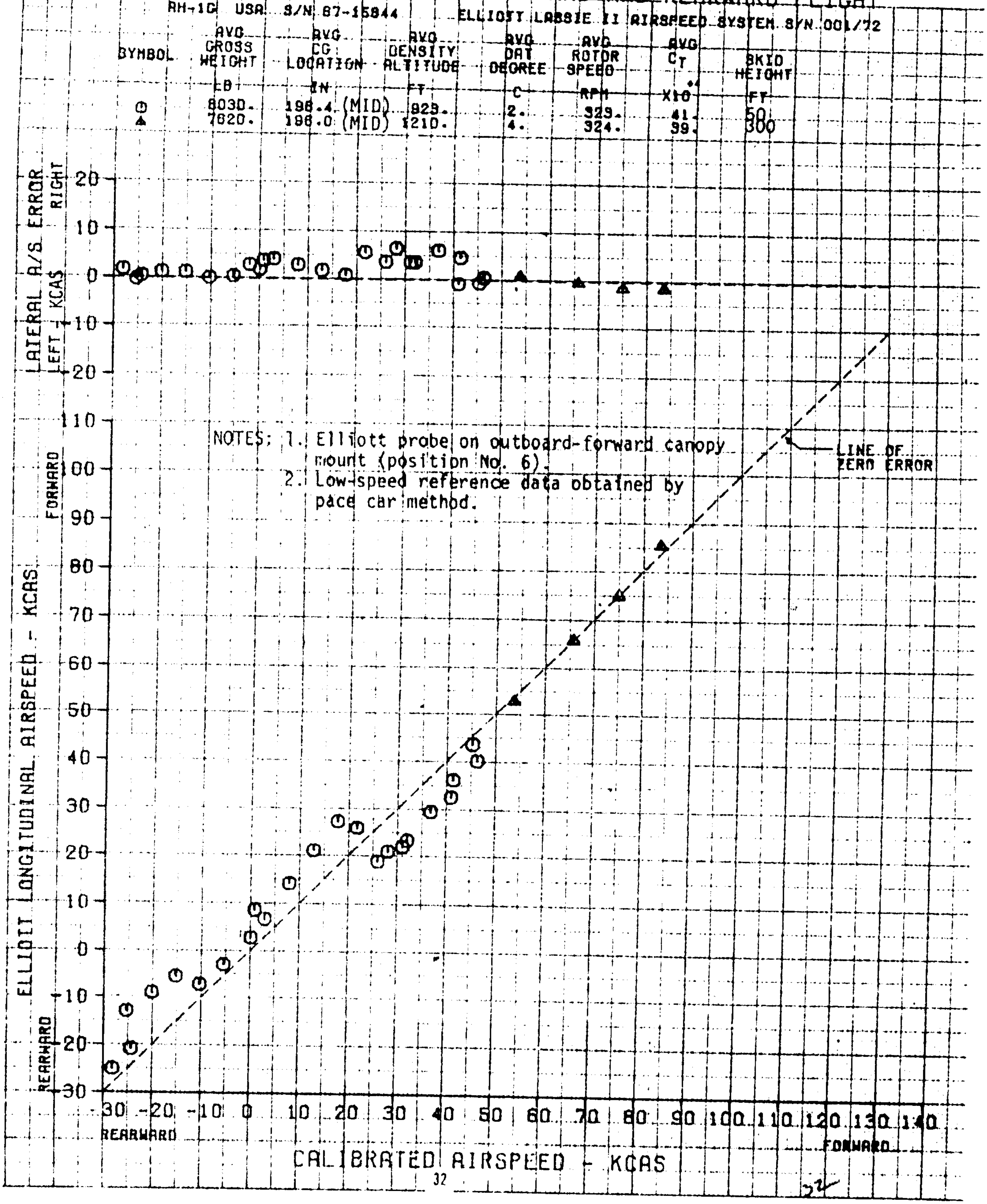


FIGURE 12

AIRSPEED CALIBRATION IN SIDEWARD FLIGHT

AH-1G USA S/N 67-15844 ELLIOTT LASSIE II AIRSPEED SYSTEM S/N 001/72

SYMBOL	AVG GROSS WEIGHT LB	AVG CG LOCATION IN	AVG DENSITY ALTITUDE FT	AVG OAT DEGREE C	AVG ROTOR SPEED RPM	AVG C_T $\times 10^{-4}$	SKID HEIGHT FT
⊙	7930.	196.3 (MID)	1080.	8.	324.	41.	50

NOTES: 1. Elliott probe on outboard-forward canopy mount (position No. 6).
2. Low-speed reference data obtained by pace car method.

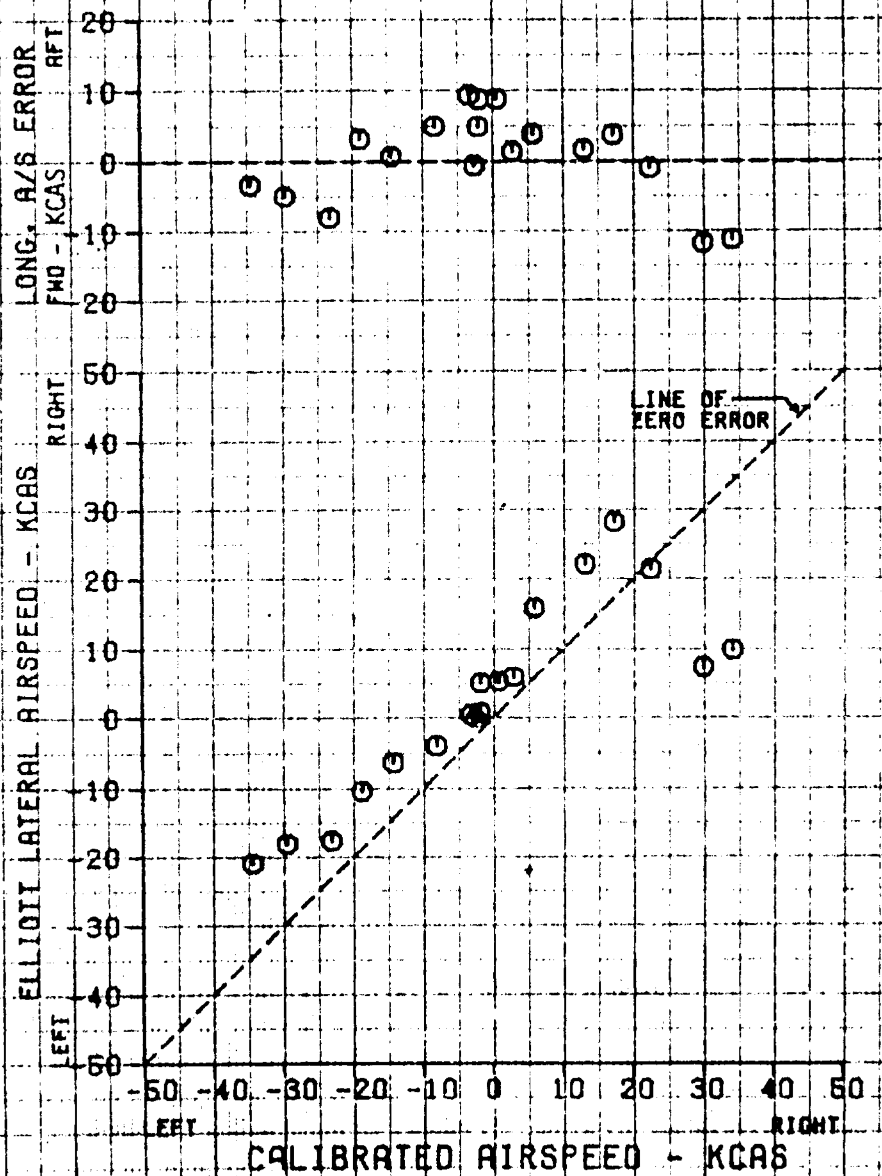


FIGURE 13

AIRSPEED CALIBRATION IN FORWARD AND REARWARD FLIGHT

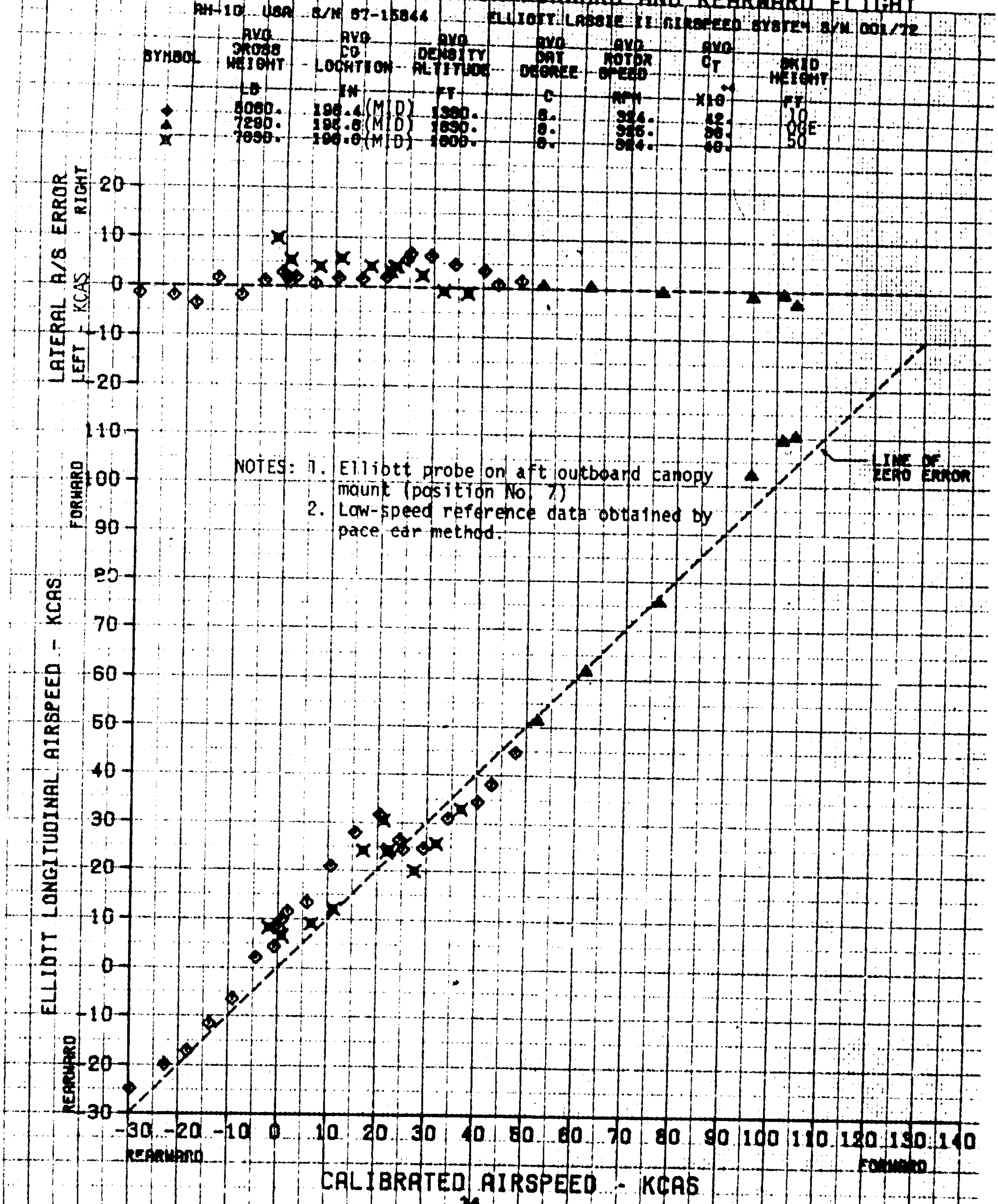


FIGURE 14

AIRSPEED CALIBRATION IN SIDEWARD FLIGHT

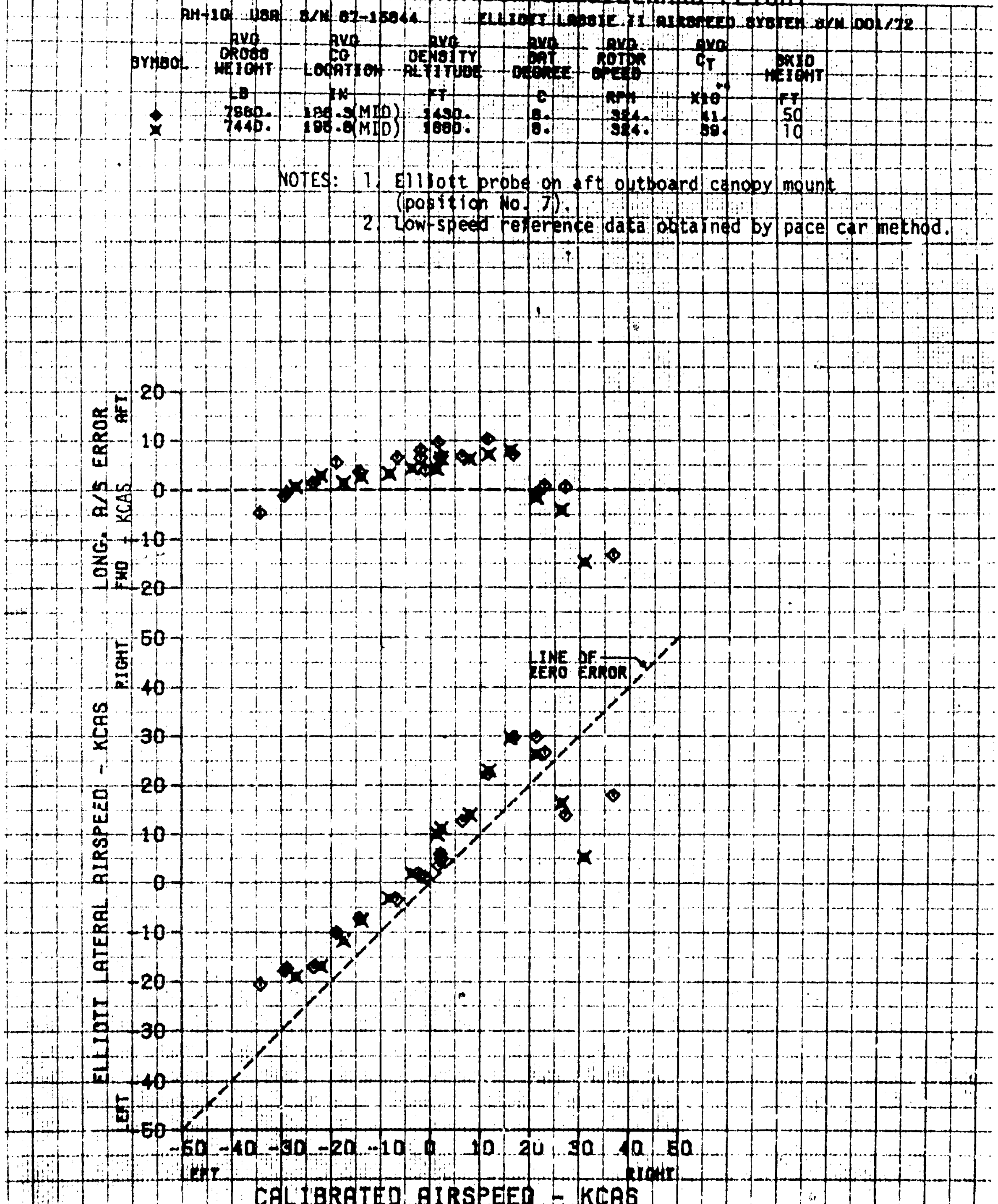


FIGURE 15

AIRSPEED CALIBRATION IN FORWARD AND REARWARD FLIGHT

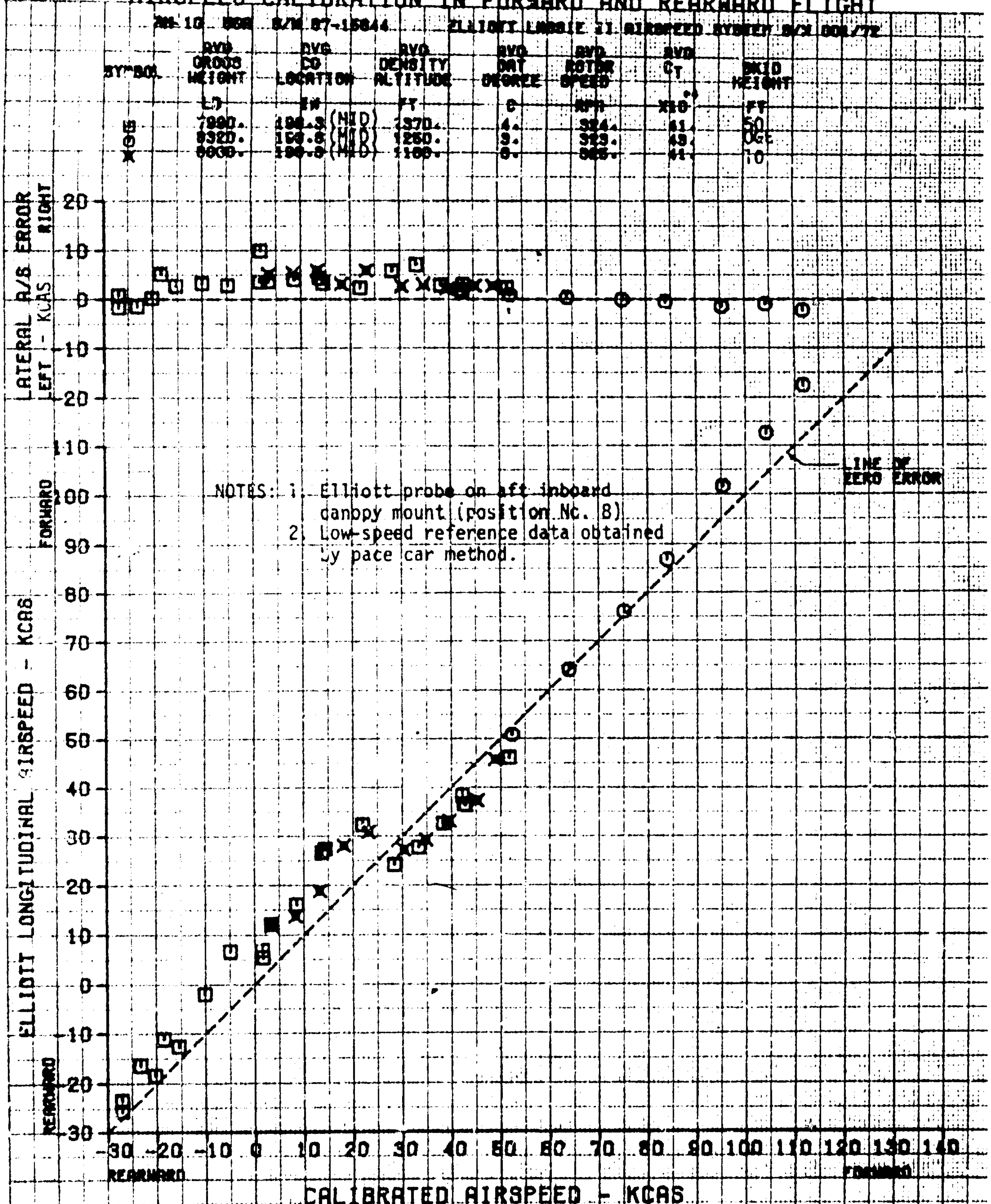


FIGURE 16

AIRSPEED CALIBRATION IN SIDEWARD FLIGHT

AH-1G USA S/N 67-15844 ELLIOTT LASSIE II AIRSPEED SYSTEM S/N 001/72

SYMBOL	AVG GROSS WEIGHT LB	AVG CG LOCATION IN	AVG DENSITY ALTITUDE FT	AVG OAT DEGREE C	AVG ROTOR SPEED RPM	AVG C_T $X10^{+4}$	SKID HEIGHT FT
☐	7880.	198.2 (MID)	1470.	5.	324.	41.	50

NOTES: 1. Elliott probe on aft inboard canopy mount (position No. 8)
2. Low-speed reference data obtained by pace car method.

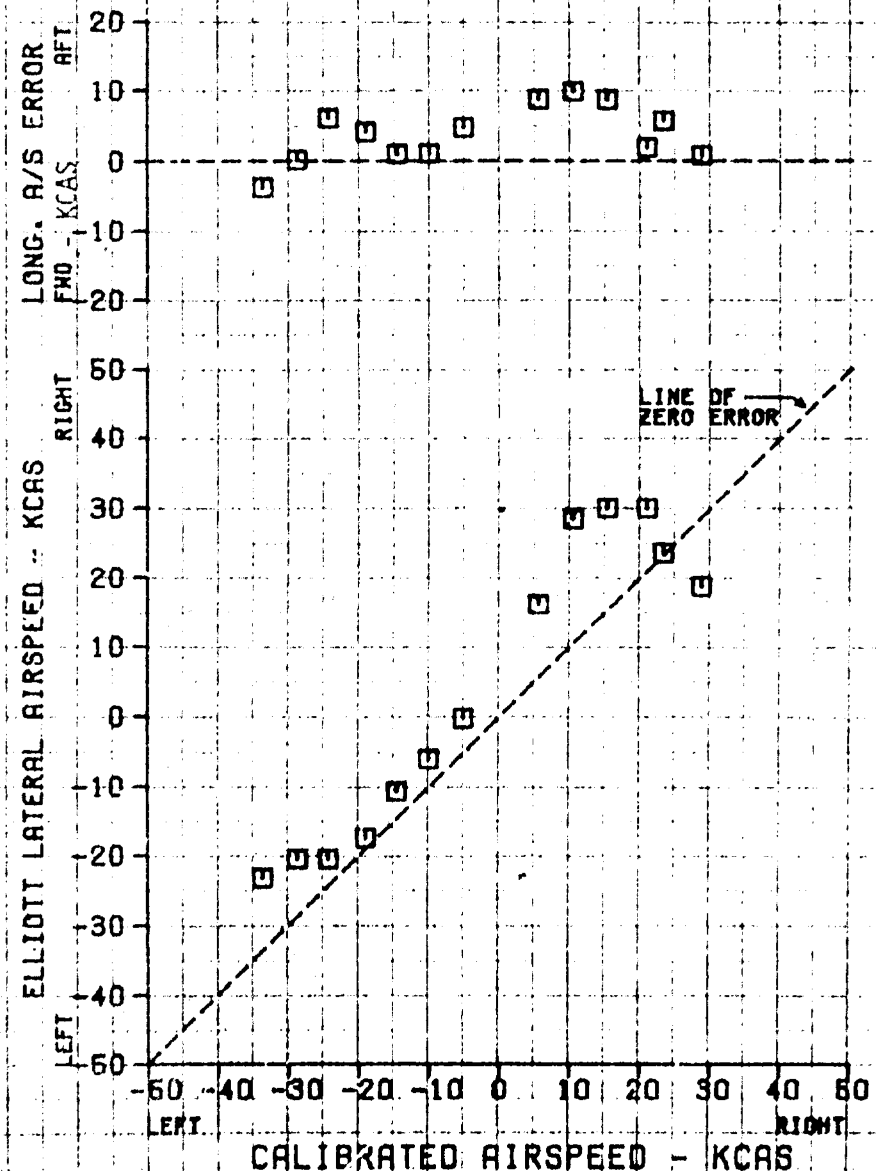


FIGURE 17

AIRSPEED CALIBRATION IN FORWARD AND REARWARD FLIGHT

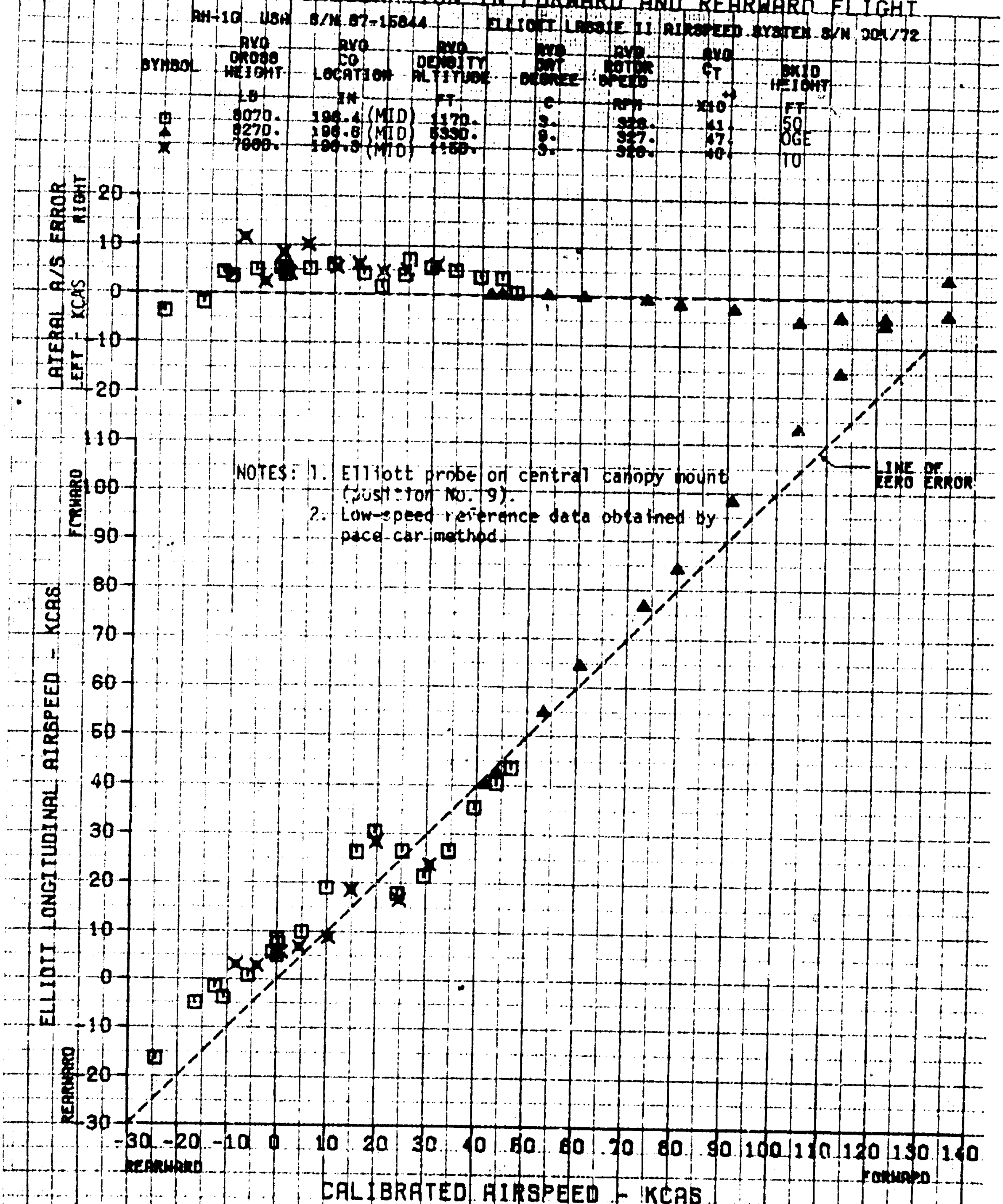


FIGURE 18

AIRSPEED CALIBRATION IN SIDEWARD FLIGHT

AH-1G USA S/N 67-15844 ELLIOTT LASSIE II AIRSPEED SYSTEM S/N 001/72

SYMBOL	AVG GROSS WEIGHT LB	AVG CG LOCATION IN	AVG DENSITY ALTITUDE FT	AVG OAT DEGREE C	AVG ROTOR SPEED RPM	AVG C_T $\times10^{-4}$	SKID HEIGHT FT
□	7720.	196.1 (MID)	1830.	8.	328.	40.	50
✕	7530.	196.2 (MID)	1820.	7.	326.	39.	10

NOTES: 1. Elliott probe on central canopy mount (position No. 9)
2. Low-speed reference data obtained by pace car method.

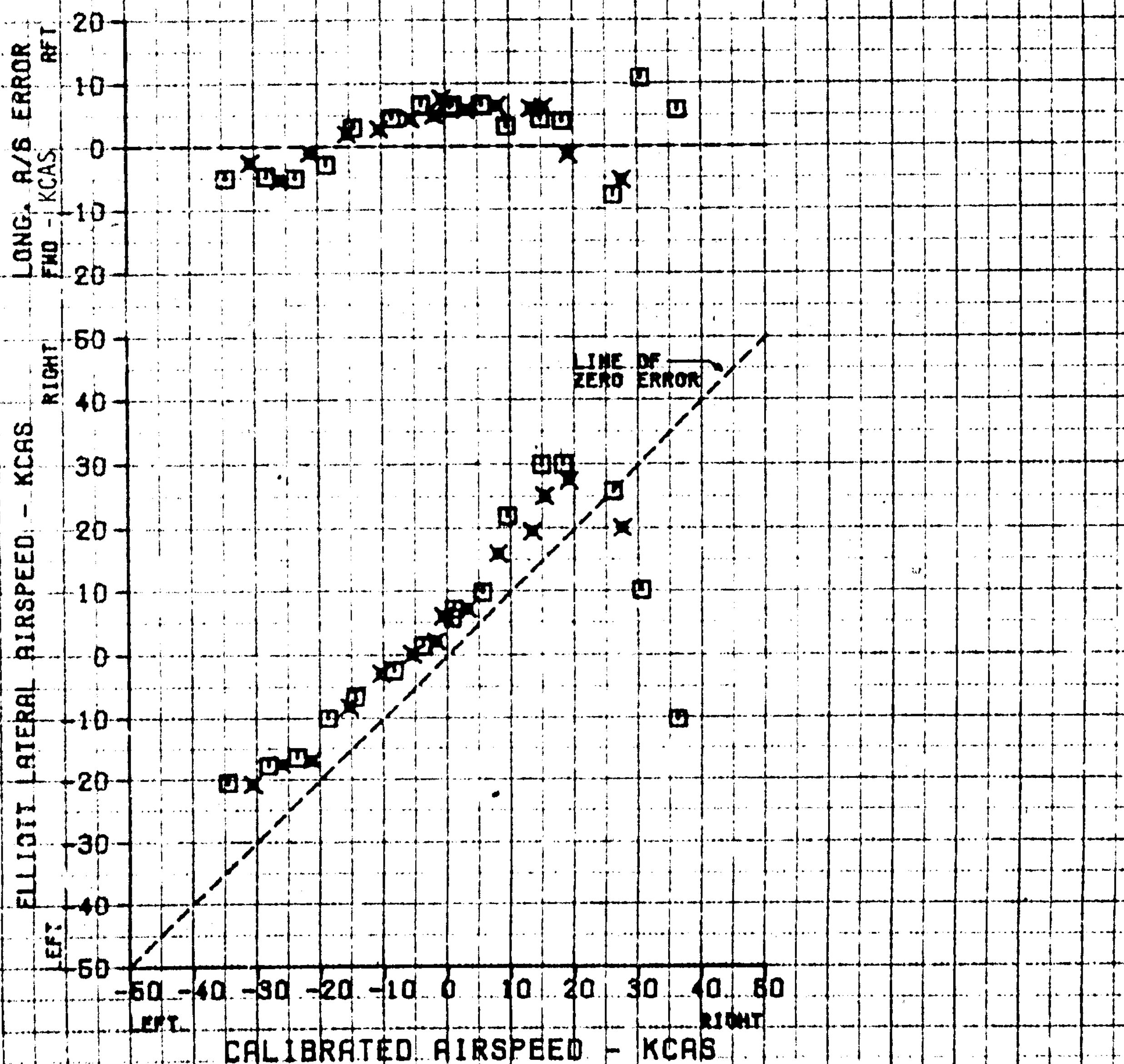


FIGURE 19

AIRSPEED CALIBRATION IN FORWARD AND REARWARD FLIGHT

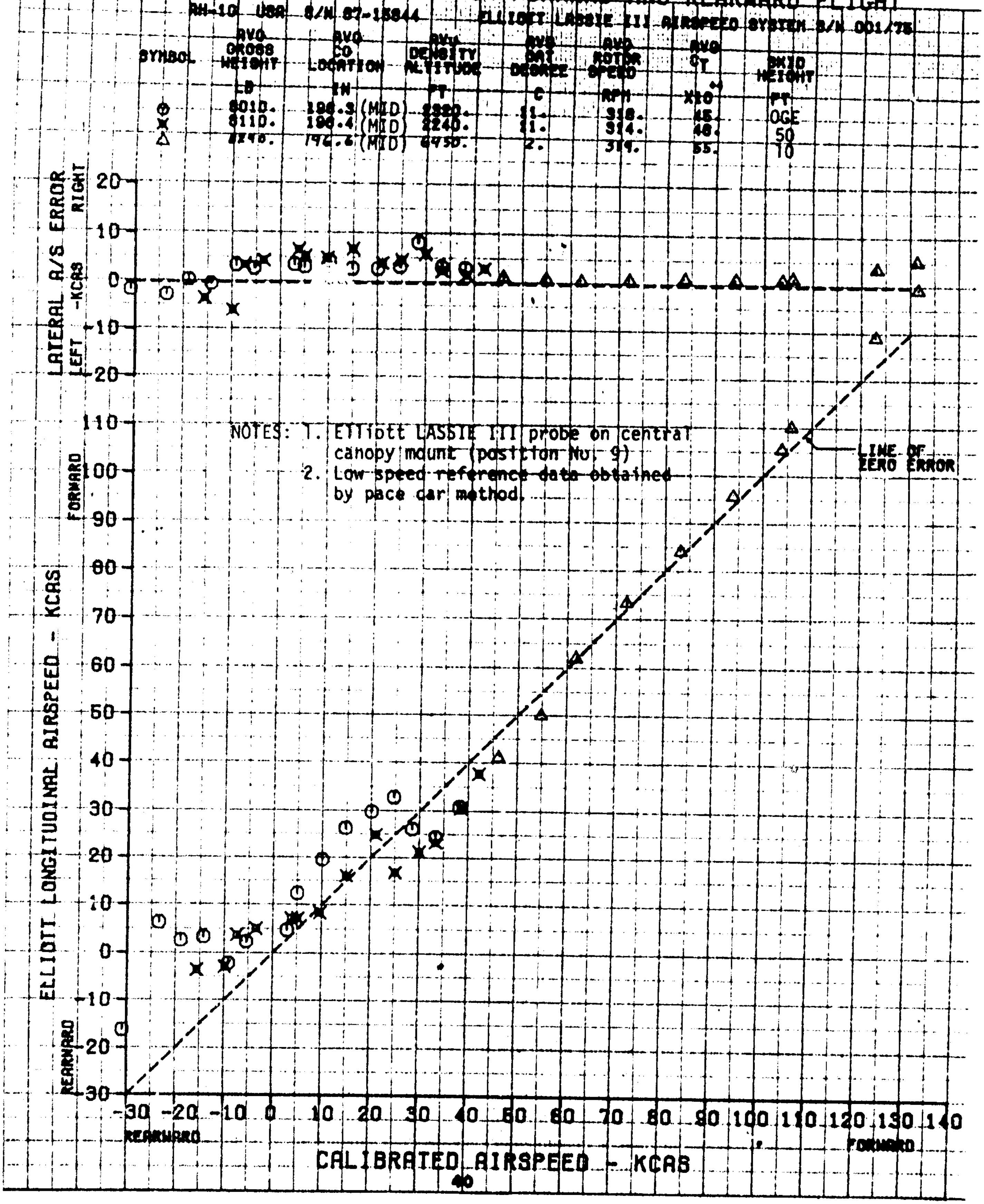


FIGURE 20

AIRSPEED CALIBRATION IN SIDEWARD FLIGHT

AH-1G USA S/N 67-15844 ELLIOTT LASSIE III AIRSPEED SYSTEM S/N 001/75

SYMBOL	AVG GROSS WEIGHT LB	AVG CG LOCATION IN		AVG DENSITY ALTITUDE FT	AVG OAT DEGREE C	AVG ROTOR SPEED RPM	AVG C_T $\times 10^{-4}$	SKID HEIGHT FT
⊙	8060.	196.4	(MID)	2370.	11.	316.	45.	50
✕	7910.	196.3	(MID)	2260.	11.	315.	44.	10

NOTES: 1. Elliott LASSIE III probe on central canopy mount (position No. 9)
2. Low speed reference data obtained by pace car method.

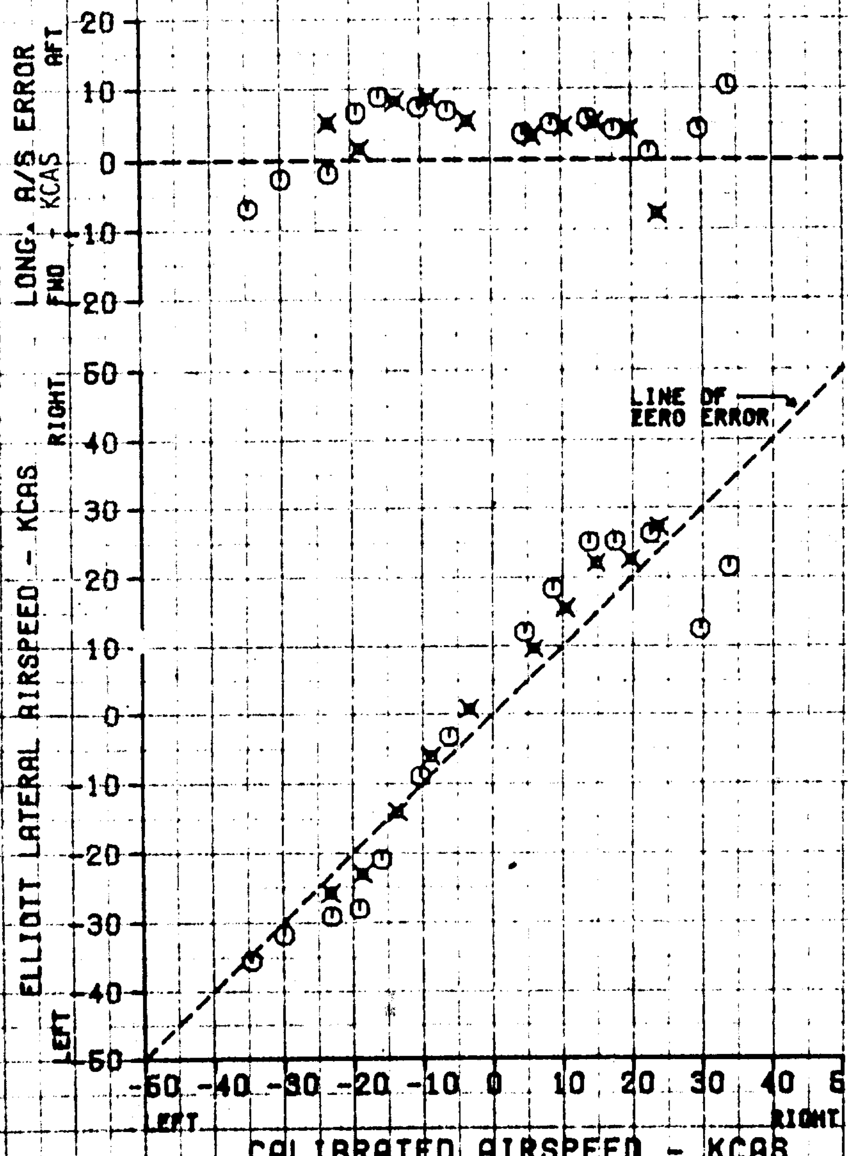


FIGURE 21
AIRSPEED CALIBRATION IN FORWARD AND REARWARD FLIGHT

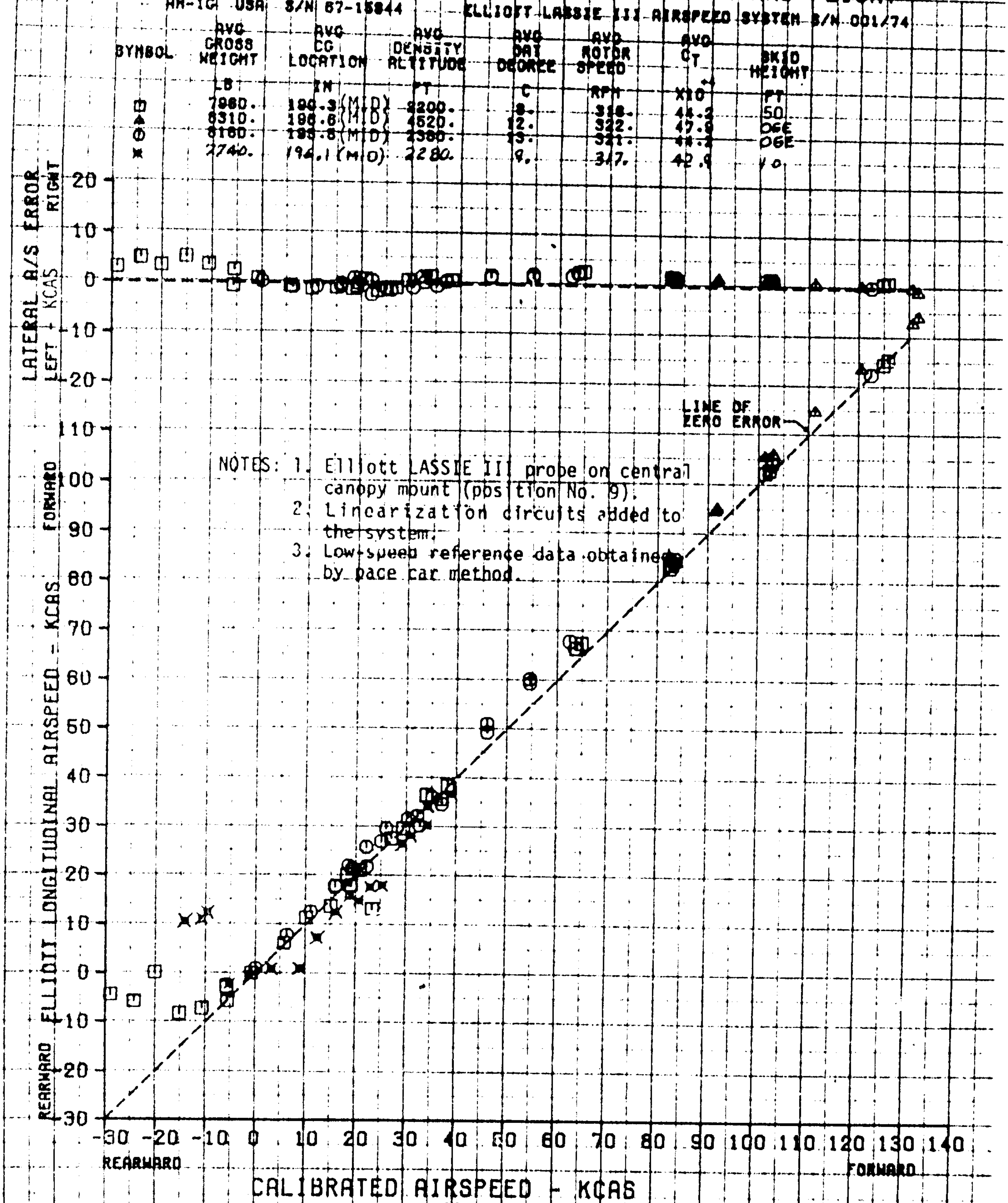


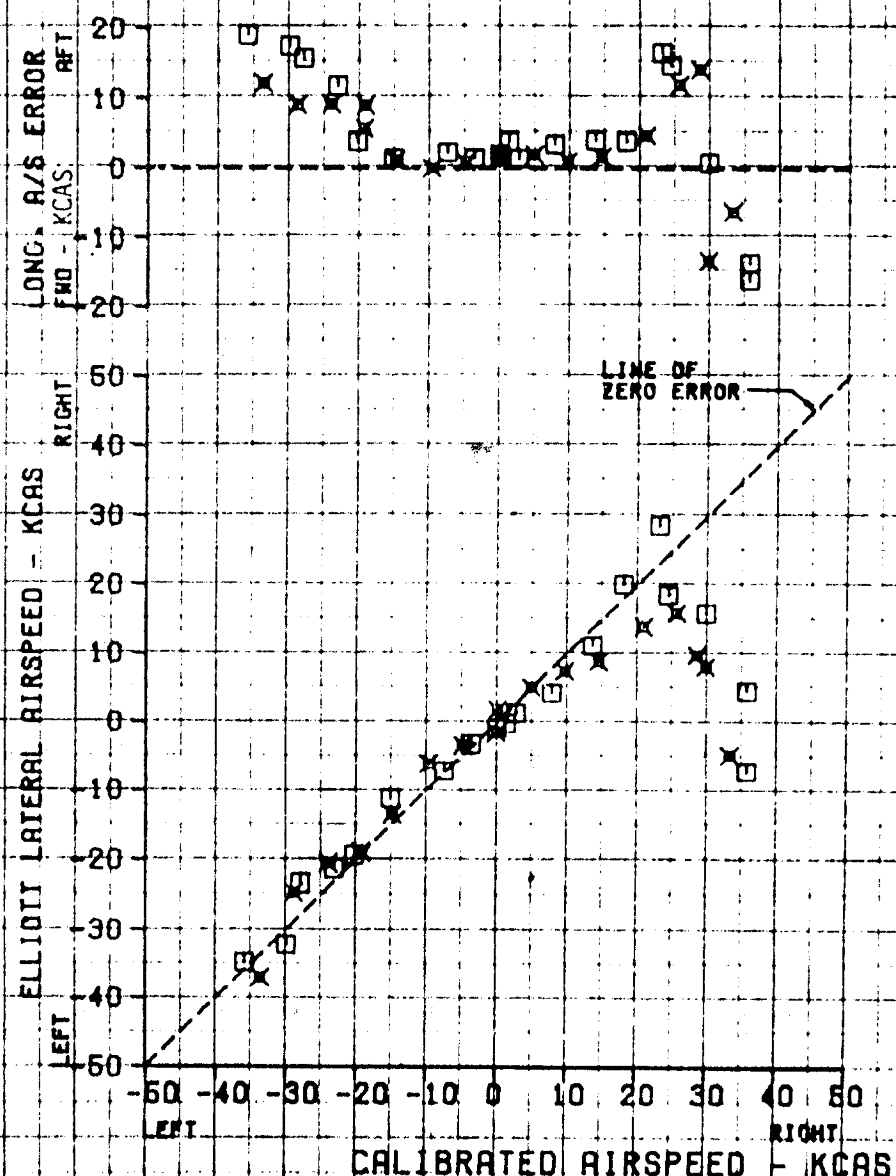
FIGURE 22

AIRSPEED CALIBRATION IN SIDEWARD FLIGHT

AH-1G USA S/N 67-15844 ELLIOTT LASSIE III AIRSPEED SYSTEM S/N 001/74

SYMBOL	AVG GROSS WEIGHT	AVG CG LOCATION	AVG DENSITY ALTITUDE	AVG OAT DEGREE	AVG ROTOR SPEED	AVG C_T	SKID
	LB	IN	FT	C	RPM	$X10^{-4}$	FT
⊡	7980.	196.3 (MID)	2350.	8.	318.	44.6	50
X	7490.	196.8 (MID)	2500.	11.	316.	42.1	10

NOTES: 1. Elliott LASSIE III probe on central canopy mount (position No. 9).
2. Linearization circuits added to the system.
3. Low-speed reference data obtained by pace car method.



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